DISSERTATION

THREE ESSAYS ON REGIONAL ECONOMIC DEVELOPMENT

Submitted by

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ABSTRACT

THREE ESSAYS ON REGIONAL ECONOMIC DEVELOPMENT

This dissertation explores factors that contribute to regional economic growth. The first two chapters focus on one of the key drivers of regional economic growth: entrepreneurship. In the first two chapters I examine how the Earned Income Tax Credit (EITC) contributes to entrepreneurship. Chapter 1 focuses on the labor demand side of regional entrepreneurship, finding the introduction of state EITC policies reduces the number of new establishments and the number of establishment expansions relative to counties in states without such a policy. In Chapter 2, at the individual level, I find that increasing the amount of the EITC increases the likelihood that the child of the credit recipient becomes a business owner as an adult. The third chapter focuses directly on what caused economic growth in Pre-Colonial India. I propose that the introduction of a New World crop, a form of an agricultural productivity shock, caused economic growth in India. I find that the introduction of maize did contribute to economic growth in Pre-Colonial India.

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DEDICATION

I would like to dedicate this dissertation to Annika

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Introductory Chapter

The spatial distribution of economic activity is often overlooked. It is not the case that all regions develop equally, nor is it the case that all regions have the same types and sizes of industries. Despite the uneven distribution of economic activity, this was not a cause for concern. People can move to regions with higher wages, and businesses would locate in areas with lower costs. These two factors helped the convergence of regional economies. However, in recent decades the convergence of regional economies has slowed or even reversed (Austin, Glaeser, and Summers 2018). This has led many to search for policies and strategies to help spur economic growth in these struggling regional economies. This dissertation explores factors that impact how different regions grow through entrepreneurship and through an agricultural productivity shock.

One of the key strategies for regional economic growth has been to emphasize entrepreneurship and encourage new business formation in lagging regions. Encouraging entrepreneurship has many benefits that may help improve local economies. One of the benefits is increased innovation. Entrepreneurs are able to exploit existing information and transform it into a new innovation, which in turn, spurs economic growth (Romer 1990; David B Audretsch 2002). Another benefit of this innovation is an increase in knowledge spillovers. The innovations from entrepreneurs increase the stock of knowledge in a regional economy which leads to new entrepreneurial endeavors, innovation and growth (Acs, Braunerhjelm, et al. 2009; David B. Audretsch and Keilbach 2004). Lastly, entrepreneurship benefits regional economic growth through its contributions to employment growth (Acs and Armington 2004; Bunten et al. 2015). New firms hire more employees and experience more employment growth than incumbent firms (Loveridge and Nizalov 2007). These benefits demonstrate entrepreneurship's important role in improving regional economies, and policies to support and promote entrepreneurship should be examined.

The first two chapters of this dissertation analyze the Earned Income Tax Credit (EITC) and how it affects entrepreneurship. The EITC is a policy designed to supplement the incomes of low- to moderate-income individuals while encouraging work. The policy was enacted in 1975 and

gave $400 to families earning less that $8,000 and has undergone several expansions since then with the largest occurring in the 2000s. In 2021 the maximum credit was between $1,502 and $6,728 depending on the number of children in the household. The EITC is primarily a federal policy, but states can also pass their own version of the EITC as well. The first state-level EITC was passed in 1986 and in 2016, 26 states and Washington D.C. had enacted a version of the EITC.

Given the size and importance of the policy, there is a large literature examining the effects of the EITC. Researcher have found that the EITC increases the labor supply of individuals, their incomes, and self-employment (Eissa and Liebman 1996; Meyer and Rosenbaum 2001; Neumark and Shirley 2020; Moulton, Graddy-Reed, and Lanahan 2016; Schanzenbach et al. 2020; Chetty, Friedman, and Rockoff 2011; LaLumia 2009; Saez 2010). The first two chapters of this dissertation extend the literature by examining how the EITC impacts entrepreneurship from both the labor demand and labor supply perspective.

Chapter 1 explores how the EITC affects contemporaneous labor demand side of the EITC and entrepreneurship. Previous research has shown that employers are able to capture some of the surplus from the tax credit in the form of paying their employees lower wages (Leigh 2010; Rothstein 2010). The captured surplus should lower the costs associated with starting a new establishment and expanding existing establishments. This dissertation develops a theoretical model to formally explain this phenomena and then empirically tests the model's implications. I find that after a state-level EITC is enacted, there are fewer new establishment births and fewer existing establishment expansions relative to places with the EITC policy. These effects are the strongest in the smallest counties. These results suggest that the EITC is limited in helping struggling regional economies in the short-term.

The second chapter examines the long-term impact of the EITC on individuals who were exposed to the tax credit as children and whether they become entrepreneurs as adults. The EITC can impact the likelihood future entrepreneurship through two channels: through the resource effect and the demonstration effect. The resource effect affects entrepreneurship directly through increases in family income from the EITC which would reduce the likelihood to participate in risky

behaviors like self-employed entrepreneurship. The other channel is the demonstration effect. The EITC may increase the entrepreneurship of the parents who receive the credit, which demonstrates to the children that entrepreneurship is a potential labor market outcome. I find that increased exposure to the EITC as a child does not increase the likelihood of becoming a self-employed entrepreneur, but that it does increase the likelihood of more productive entrepreneurship in the form of business ownership. I explore which channel affects these results the most and determine that the resource effect is the most likely factor.

The final of this dissertation chapter explores a direct cause of the differences in regional economies. Differences in technological innovations can affect the growth of different regions. I test whether a new technology in the form of a newly introduced crop is sufficient to spur economic growth in Pre-Colonial India. Maize, the crop on which I focus, can function as a technological innovation during this period because it was more productive and more nutritious than the existing crops. By being more productive, places that are particularly well suited to grow the crop may experience more economic growth than places that do not have as suitable growing conditions. By being more productive and nutritious, fewer people are needed to produce sufficient food for survival, and frees people to pursue more productive sectors in the economy. I do find evidence that the introduction of maize increases economic growth for those regions. The effects are even more pronounced when spatial spillovers are taken into account. Agricultural productivity shocks similar to this one may help explain why certain regions grow, while others do not.

Each chapter helps further the knowledge base on how regional economies develop. Chapters 1 and 2 examine how a policy can affect one of the main drivers of regional economic growth, and chapter 3 examines a direct cause of differences in regional growth.

Chapter 1

Does the Earned Income Tax Credit Birth New Establishments?

1.1 Introduction

Regional economics has long recognized geographical differences in economic outcomes. This has not been of much concern due to the mobility of people and capital. Historically, individuals would migrate from low wage areas to high wage areas in search of better jobs and pay. This would increase the competition for jobs, applying downward pressure on wages. At the same time capital would flow to low wage areas, increasing the opportunities for job seekers. These dynamics caused regional economies to converge. However, regional convergence has slowed highlighting the need for policies to help the economically lagging regions (Austin, Glaeser, and Summers 2018). The Earned Income Tax Credit is one such policy that has been suggested as a solution.

The Earned Income Tax Credit (EITC) is one of the largest cash transfer programs in the United States. Primarily targeted at low income working people, the EITC is designed to supplement their incomes while encouraging work. Beginning in the 1980s states implemented their own versions of the EITC to supplement the federal credit. Due to its work requirement, the Earned Income Tax Credit has been suggested as a policy to help economically lagging regions. In order for this to be an effective solution, the increase in labor supply from the introduction of the tax credits needs to also be met with an increase in labor demand.

In this paper, I answer whether state level Earned Income Tax Credits causes new firms to be born. I also examine if the Earned Income Tax Credits influences other firm decisions including the decision to expand, contract, or close. The Earned Income Tax Credit may impact these decisions since firms are able to capture some of the surplus of the credit by paying their employees lower

wages (Rothstein 2010; Leigh 2010). Firms may decide to locate in states with a state EITC policy in order to lower their wage bill by capturing more of the surplus from the Earned Income Tax Credit. Lower employment costs may have other advantages as well. Firms may be more likely to hire more workers since the marginal cost of an additional worker is lower in the presence of the state credit. This may also cause firms to be less likely to layoff workers or close down.

This work extends the literature in three important ways. First, I examine how the Earned Income Tax Credit impacts the establishment's decisions to open. The majority of the work studying the impacts of the policy focuses on its impacts on individuals; either the recipient or their offspring. I first use a panel of all counties in the United States to test whether counties in states with an EITC policy experience more establishment births than counties in states without such a policy. Establishment births are of particular interest because an establishment counts as being born when they hire their first employee. The costs of hiring the first employee are greater than the costs of hiring subsequent employees dues to the fixed costs associated with hiring. For an entrepreneur to make the transition from not having any employees (a non-employer) to an employer establishment, the entrepreneur needs to be successful enough to afford these fixed costs and the wages of the employee. I do not find any significant effects for both the existence of the policy and the generosity of the policies for establishment births. I then use a sample of contiguous cross-border counties because if the marginal establishment birth is influenced by state EITC policies then any difference in outcomes will most likely occur in counties that are more similar, where the only meaningful difference is the EITC policy. Using this sample of counties, I find that the existence of the Earned Income Tax Credit significantly reduces the difference in the number of establishment births between counties with the policy and those without.

Second, this paper investigates how state Earned Income Tax Credit policies impact other business decisions. Specifically it extends the analysis to examine how the EITC impacts establishment deaths, employment expansions, and employment contractions. Given that employers are able to capture some of the surplus from the tax credit, this is likely to affect existing establishments as

well. These effects will show up in the decision to expand or contract employment or ultimately shutdown. Using the same methodology as before, I find that the EITC reduces the difference in the number of establishments that expand employment between counties with the policy and their cross-border counterpart that does not. I do not find evidence that the EITC significantly impacts the difference in the number of establishment deaths or establishment contractions.

Finally, I analyze whether the effects of state EITC policies are the same for metropolitan, micropolitan, and rural counties. This is important because rural areas on average display higher and more persistent rates of poverty, so the Earned Income Tax Credit policies may be more salient in these areas for individuals and establishments. Also, the effect of these policies may be different across the different types of counties because of their densities and agglomeration economies. When testing heterogeneous effects of the EITC policies for these classifications of counties, I find that the cross-border county results are driven mainly by the micropolitan and rural counties. There is not a significant difference between cross-border metropolitan counties with the tax credit and without.

The rest of the paper proceeds as follows. Section 2 reviews the relevant literature. Section 3 presents a simple theoretical model to motivate the empirics. Section 4 describes data sources and the construction of the samples. Section 5 outlines the empirical methodology. Section 6 presents the main results of the paper, including potential mechanisms and Section 7 concludes.

1.2 Previous Literature

This work builds on and contributes to several strands of literature. First, my results contribute to the literature on the effects of the Earned Income Tax Credit. Many studies have focused on the labor supply effects of the EITC. Eissa and Liebman (1996) find that the expansion of the federal credit in 1987 increased the labor force participation of single mothers relative to single women without children. Given the structure of the EITC single women already in the labor force should, according to theory, decrease their work hours to increase their total earnings from wages and the

credit, but no such effect is found (Eissa and Liebman 1996). Others have found that over 60% of the increase in the weekly and annual employment of single mothers from 1984-1996 can be attributed to the EITC and other tax changes from this time period (Meyer and Rosenbaum 2001). Using all federal and state expansions, Schanzenbach et al. (2020) find that the EITC does increases the extensive margin of labor supply. Most of these effects are for contemporaneous changes in the EITC, but the EITC has long term effects on the labor market outcomes of women as well. A more generous EITC leads to higher cumulative earnings and greater labor market experience for unmarried mothers with children in the long term (Neumark and Shirley 2020). However, when children are too old to count as a qualifying child for the credit, women, who would likely qualify for the credit, decrease their labor force participation by 3.3-8% compared to women who still have qualifying children (Moulton, Graddy-Reed, and Lanahan 2016). Combined, these studies suggest that the EITC is an important factor in determining who is in the labor force and how large it is, which could be an important determining factor for where an establishment decides to open.

While most of the the research on the Earned Income Tax Credit has focused on the labor supply decisions of individuals, there has been some research on its effect on business. Individuals can satisfy the work requirement through becoming self-employed and forming their own business. Earned Income Tax Credit expansions increase the likelihood that individuals report self-employment income (LaLumia 2009). Saez (2010) also finds that individuals increase their reported self-employment income in order to maximize amount of the EITC they receive, and this behavior increases in areas with higher concentrations of EITC filers (Chetty, Friedman, and Saez 2013). The self-employment effects fo the EITC are important for this study because areas with higher entrepreneurship are associated with more dynamic economies (Bunten et al. 2015) and more establishment births.

Rothstein (2010) and Leigh (2010) both focus on employer firms and find that the EITC affects those firms as well. Employers are able to capture 55% of the marginal dollar given to single mothers in the form of reduced wages (Rothstein 2010). The EITC not only lowers the wages of

workers most likely to qualify for the EITC but also those who are ineligible for the credit as well (Rothstein 2010). Using state EITC policies, Leigh (2010) finds that a 10 percentage point increase in the generosity of the polices is associated with a 5 percent fall in hourly wages of high school dropouts and a 2 percent decrease for those with a high school diploma, and these results hold for both workers who qualify and for the credit and those who do not. These results are important because if firms are able to lower their wage bill by capturing a portion of the surplus from the EITC then firms may be more likely to locate in areas with such a policy.

Second, I contribute to the literature on the effect of local characteristics on firm location. The prevalence of unionization and high local taxes reduces the amount of business that locate in a state (Bartik 1985; Holmes 1998; Guimaraes, Figueiredo, and Woodward 2004; Duranton, Gobillon, and Overman 2011). Different organizational structures of firms react differently to corporate tax rates. A 1 percentage point increase in the corporate tax rate reduces the number of openings by 0.5 percent and a decrease of 0.4 percent for S-corporations (Giroud and Rauh 2019). The effects of local corporate taxes can be mitigated though; agglomeration economies lessen the impact of taxes of firm location decision (Brülhart, Jametti, and Schmidheiny 2012). Research and development spending at universities also create externalities that increase the number of manufacturing births (Woodward, Figueiredo, and Guimarães 2006). The Earned Income Tax Credit could be another determining local factor for where businesses establish themselves.

Third, this paper also contributes to the literature on place-based policies. The conventional spatial equilibrium model finds that place-based policies are distortionary since factors of production are perfectly mobile and land and labor markets are perfectly competitive. Thus, place-based policies tend to favor landowners and new migrants (Bartik 1991). For these reasons economists have argued against using geographically targeted policies (Glaeser and Gottlieb 2008). People are not as mobile as originally thought, however, suggesting that placed-based policies may be an effective tool for helping struggling regions (Partridge et al. 2015). (Austin, Glaeser, and Summers 2018) provide evidence that the economic convergence between regions is slowing, and that the

rate of non-working has nearly tripled for prime-aged men in the last 50 years. As a remedy, they point to place-based policies and a focused EITC as one of the potential solutions. Place-based policies have also been shown to be effective in increasing employment (Bartik 2020; Ku, Schönberg, and Schreiner 2020). This work will test whether state Earned Income Tax Credit policies are an effective policy to increase local labor demand.

1.3 Theoretical Model

This section presents a simple theoretical model to motivate the empirical analysis and clarify how the Earned Income Tax Credit can influence the business decisions of entrepreneurs. I build upon and adapt the theoretical model in Holmes (1998) to the current research question. This model helps reinforce the decision to focus on the difference in state EITC policies at the borders. This model is also flexible enough to include other policy considerations which may help explain the empirical results.

As in Holmes (1998), the economy is modeled as a line segment with different locations indexed by $y \in [-1, 1]$. For simplicity there are only two states in the economy and $y = 0$ is the border between them. Locations $y \leq 0$ are in *State A* and locations $y > 0$ are in *State B*. *State A* is a state that has a state-level Earned Income Tax Credit and the policy is absent in *State B*. Further, assume that initially potential entrepreneurs are uniformly distributed along the line segment before starting their business and should an entrepreneur undertake their project they will hire a low-wage employee.

The potential entrepreneur is faced with three options: they can set up their business at their initial location y, they can choose to not set up their business, or they can move and set up their business in a new location. Let q be the productivity of the entrepreneur which will equal the amount of the final goods and services produced should the entrepreneur start their business and hire a low-wage employee. q is uniformly distributed on the unit interval and is independent of

location. Let the workers be perfectly homogeneous and mobile, and are paid the competitive wage, w, which is constant across locations.

If the entrepreneur decides to under take their project in *State B*, their profit equals their productivity less the competitive wage w: $\pi_B = q - w$. If an entrepreneur decides to begin a business in *State A*, the entrepreneur receives a wage subsidy, s. The wage subsidy come from the surplus that employers are able to capture from the state EITC policy that exists in *A*, but is absent in *B*. Profit becomes $\pi_A = q - (w - s)$ less any moving costs.

As previously mentioned, one of the choices the entrepreneur can make is to move and set up their business in a new location. With probability p, an entrepreneur is initially located at some location $y > 0$ in *State B* has an alternate location $y' < 0$ in *State A*. Given that there is an alternative for the entrepreneur to move, assume this location is drawn from a uniform distribution over the set of locations in *State A*, $y \in [-1, 0]$. Let the cost of moving be a function of the distance traveled from y to y' such that the cost is equal to $t \times (|y - y'|)$. This implies that the farther one moves from their initial location the higher the cost. This formulation also prohibits the entrepreneurs from moving to $y' = 0$ to minimize their moving costs. The initial location may have specific features that do not exist at the border of *A* but do exist at a more interior location.

The number of entrepreneurs at any location y is the number of entrepreneurs who choose to set up their business at their initial location plus any entrepreneurs who move to y to open their business. There exists a critical distance, $\hat{y}$ such that it does not make economic sense for the entrepreneur to move. This distance is defined as $t\hat{y} \equiv s$. At this point the cost of moving locations is greater than the subsidy captured from the state EITC policy. This means that locations $y > \hat{y}$ in *State B* are too far from the border and it never would be worth moving locations. The entrepreneurs at these locations have a productivity level $q > w$. Let the number of entrepreneurs at these locations be denoted e. Similarly, in *State A* there are locations that are too far from the border to which it does not make economic sense for entrepreneurs to move: $y < -\hat{y}$. Let the

number of entrepreneurs located at these locations be equal to e' and $e' > e$ since the wage subsidy from *State A's* EITC policy lowers the level productivity required to undertake an entrepreneurial endeavor. This is illustrated in Figure 1.1.

Figure 1.1: Level of Entrepreneurship away from the Border

Now consider locations $y \in (0, \hat{y})$. Entrepreneurs in this region may be lucky enough to obtain locations where $t \times (|y - y'|) < s$ thus moving does make economic sense. The lower y is the higher the likelihood that there is a location in *A* to which it is worth moving. Based on this increased probability the number of entrepreneurs near the border in *State B* is lower than the number of entrepreneurs in *State A* near the border. Right at the border where there is a change in state EITC polices, there is a discontinuous jump in the number of entrepreneurs. As y continues to decrease and moves further towards the interior of *A*, the number of entrepreneurs decreases because as you move farther from the border the number of entrepreneurs willing to pay the moving costs decreases. This dynamic is demonstrated in Figure 1.2.

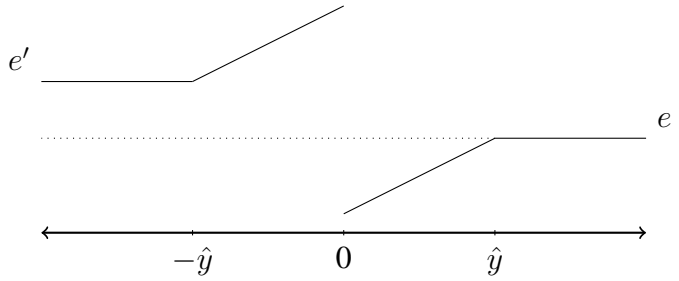

Figure 1.2: Entrepreneurship Dynamics at State Border

Let the status quo be the case where neither state has an EITC policy. In this case, the number of entrepreneurs will be equal to e at all locations in both states. This is illustrated by the dotted line in Figure 1.2. After the initial period, *State A* decides to implement an EITC policy. This increases the number of entrepreneurs at all locations in *A* because the entrepreneurs are able to subsidize their wage bill by capturing some of the EITC surplus. Away from the border, the increase in the number of entrepreneurs in not as large as near the border because those locations are too far for entrepreneurs to move. At the border, the subsidy attracts entrepreneurs with locations in *State B* that are closer to the border than the critical distance $\hat{y}$. This result provides the motivation for the empirical analysis to focus on the effects of the EITC near the state border.

It is also possible for the EITC to have different effects on entrepreneurship. Given that the EITC is designed to be a benefit for the individual, the savings on wages may not be the most salient feature of the policy for entrepreneurs. The state credits may be funded at least in part by increases to the corporate tax rate. This tax rate increase may be more salient for entrepreneurs or the tax may dominate the wage subsidy. This model can be adapted to account for these possibilities.

Suppose that in the absence of the EITC in *State A*, both states have the same corporate tax rate. In this initial state the number of entrepreneurs is the same as before, e. Now, when *A* enacts the EITC policy it also increases the corporate tax, τ, to help fund the benefit. The profit function for entrepreneurs in *State A* becomes: $\pi_A = q - (w - s) - \tau$ less any potential moving costs. From this there are two possible outcomes depending on the magnitude of the tax.

If the tax is less than the wage subsidy entrepreneurs are able to capture from the EITC surplus, then the outcome is similar to scenario without the tax. There is some critical distance, $\tilde{y}$, such that it does not make economic sense for the entrepreneur to move. This distance is defined as $t\tilde{y} \equiv s - \tau$. At this point locations in *B* where $y > \tilde{y}$ are too far from the border to move. The entrepreneurs at this location still have a productivity level $q > w$ and the number of entrepreneurs is e. This is the same level as the no-tax situation because the conditions on this side of the border

have not changed. However, notice that the new critical distance is closer to the border because the amount of the surplus entrepreneurs are able to capture is small when $s > \tau$. On the opposite side of the border, there are locations that are too far from the border for it to make moving worthwhile: $y < \tilde{y}$. The number of entrepreneurs here is equal to e''. This is greater than e because the subsidy is greater than the tax still making the required productivity level for success lower. The existence of the tax, however, makes it less than e' in the no-tax situation. Locations $y \in (0, \tilde{y})$ may have entrepreneurs where $t \times (|y - y'|) < s - \tau$ and moving makes economic sense.

The status quo case where neither state has an EITC policy is the same as the no-tax status quo. The number of entrepreneurs is e on both sides of the border and is denoted by the dotted line in Figure 1.3. Now, *State A* enacts the EITC and the corporate tax to pay for the credit. This will increase the number of entrepreneurs in *A* at all locations because they are still able to capture some of the surplus in the form of lower wages. Near the border there is a decrease in the number of entrepreneurs in *State B* because some decide to move to capture some of the EITC surplus, which causes the number of entrepreneurs near the border in *A* to increase. This is illustrated in panel (a) of Figure 1.3.

The second case is when $\tau > s$. Here the subsidy is dominated by the increase in the corporate tax rate. In this scenario the entrepreneur's profits after policy implementation in *State A* is $\pi_A = q - (w - s) - \tau$ but this is lower than the profits for entrepreneurs in *B* without the policies: $\pi_B = q - w$ less any potential moving costs. Now there is some critical distance, $\tilde{\tilde{y}}$, for which it does not make sense for entrepreneurs in *A* to move to *B*. Let this be defined as $\tilde{\tilde{y}} \equiv \tau$. Entrepreneurs at locations $y < -\tilde{\tilde{y}}$ are too far from the border to move to avoid the corporate tax. The number of entrepreneurs at this location is equal to the number of entrepreneurs that have a productivity level $q > (w - s) + \tau$, denoted e'''. Similarly, in *B* there are locations that are too far from the border to which entrepreneurs can move, $y > \tilde{\tilde{y}}$. The number of entrepreneurs at this location is still equal to e. Since the productivity threshold in *B* (w) is lower than the productivity threshold in *A* ($(w - s) + \tau$) this implies that $e > e'''$. Entrepreneurs in the region $y \in (-\tilde{\tilde{y}}, 0)$ may be lucky

enough to have locations worth moving to. Again the closer y is to 0 the greater the likelihood the entrepreneur has a location worth moving to. This accounts for the decrease in entrepreneurs the closer y is to 0. As one crosses the border into *B*, there is a jump in the number od entrepreneurs near the border that decrease as y increases.

The status quo case without the EITC or the tax remains the same as in the other scenarios and is represented by the dotted line in panel (b) of Figure 1.3. After enacting the EITC and tax policy, the number of entrepreneurs decreases in *State A* as they react to the tax being greater than the subsidy. This effect is small far from the border, but there is a large effect near the border driven by the entrepreneurs who are able to make a small move just over the border into *B* to avoid the tax increase. The effect of *State A* increasing corporate taxes fizzles out away from the border.

There is another possible outcome for the effect of the EITC policy being different than in Figure 1.2. Since the EITC is designed as a benefit for low-income individuals, the policy may not be salient to the entrepreneur. If the EITC is not salient and the credit is not funded by a corporate tax increase, then the result of the model is the status quo case with the number of entrepreneurs equal to e in both states. If the credit is funded by a corporate tax increase, but the credit is not salient, then the outcome is panel (b) of Figure 1.3 regardless of the tax's magnitude.

In the empirical model, I test whether the state Earned Income Tax Credit policies impacts the business decisions of entrepreneurs located near the state border. I pay special attention to employer entrepreneurs and their decision to open a new establishment (an establishment birth) or to expand their employment at an existing establishment. Establishment births are of particular interest because a new establishment is considered as being born when the entrepreneur hires their first employee. The transition from a non-employer (an entrepreneur without any employees) to an employer is a significant decision for the entrepreneur, as hiring the first employee is often harder than hiring subsequent employees given the fixed costs of becoming an employer. The subsidizing effect of the EITC may lower the barrier to becoming an employer. Establishment expansions may

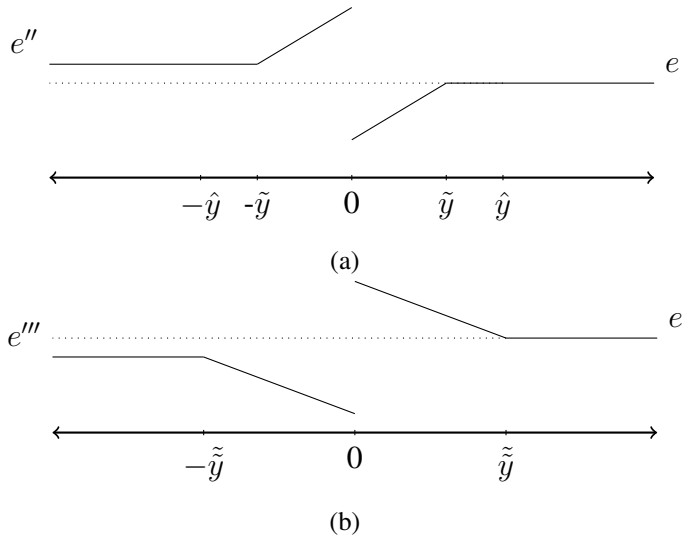

Figure 1.3: Entrepreneurship Dynamics at State Border with Tax

be similarly affected by the policy since the wages of new employees may also be subsidized after the implementation of the policy.

Based on this model, the main determining factor in whether the EITC increases the number of hires (either first or subsequent) is the magnitude of the subsidy relative to the tax. If the wage subsidy is larger than the tax then there should be more establishment births and expansions in the the state with the EITC policy relative to its cross-border counterpart without the policy. If the tax is greater than the subsidy, or if the tax is more salient, then there will be fewer establishment births and expansions in the state with the EITC relative to the neighboring state without.

1.4 Data and Sample Construction

This study is built on making comparisons between local economic areas that are contiguous and similar but differ in the existence of a state Earned Income Tax Credit policy. Since I am interested in these policies' effects on the decision of where a business opens, I utilize data from the U.S. Census Bureau's Statistics of U.S. Businesses Employment Change Tables for my main outcome of interest: establishment births. These data contain information on the number of existing establishments, establishment births, establishment deaths, establishment expansions, and

establishment contractions. Establishment births are a useful metric for measuring the impact of the EITC on labor demand and new business formation. An establishment is counted as being born when it hires its first employee. If state EITC policies are an effective way to increase local labor demand, then this will appear in the number of establishment births in a county.

The other primary source of data needed for this work is on state EITC policies. This comes from the Tax Policy Center. These data contains information on which states have enacted state Earned Income Tax Credit policies, when the policies were enacted, and how generous each state's policy is represented as a percentage of the federal credit. These data combined with the data on establishment births, allow me to identify the effect of the Earned Income Tax Credit on establishment births.

I use three different panels of counties: one that includes all counties, one that includes all contiguous border county-pairs, and a sample of contiguous border county-pairs where one county enacts the EITC and the other never enacts an EITC policy during the sample period. The construction of the second and third panels will be discussed in more detail. The first panel uses all counties in the contiguous United States over the years 2001 to 2015 for a total of 46,134 observations. This provides a baseline set of estimates for the effect of the Earned Income Tax Credit on establishment births. It is possible that there are unobserved factors associated with a county that partially determine an establishment's decision to open in a particular location. While some of these factors can be controlled for through the inclusion of county and year fixed effects, some unobserved factors still remain. Also, this sample implicitly assumes that one county in the United States is just as good as any other. Instead of weighing all options equally for where to open a new establishment, decision makers generally target areas that are attractive for their business instead of deciding between all possible options. The use of the cross-border county sample solves some of these issues.

By using the cross-border county sample I can better solve the outlined problems of the all county sample. The use of this sample allows one to control for more unobservable characteristics of the counties than by just using county and year fixed effects with the all county sample. There are economic and cultural ties between counties which may impact the decision to open. By focusing on the subset of counties that share a state border, I am able to control for these unobserved factors. This sample also improves on the all county sample by the fact that a county is more similar to its cross-border counterpart than a randomly chosen county both in observable and unobservable features. Assuming that the decision maker is targeting an area, the cross-border county sample contains pairs of counties that are similar with a sharp policy change at the border. This allows for a more precise estimation of the effect of the Earned Income Tax Credit on establishment births.

The all cross-border county sample consists of all counties that neighbor each other across a state border. The other cross-border county sample starts the same as the all border county sample but only keeps the county-pairs where one of the states has a state Earned Income Tax Credit policy and the other state does not. There are 1,139 counties in the United states that lie along a state border, and of these counties there are 750 counties that have are along state borders with a difference in the existence of state EITC policies at some point in the observational period. Since counties are not uniform in size, it is possible for counties to be share a state border with multiple counties. I consider all cross-border county pairs, so an individual county will show up in the sample as many times as it has cross-border neighbors.

Table 1.1 provides the descriptive statistics for the two samples. Comparing the samples, I find that the two sets of counties are similar to each other across most of the outcomes and controls. The similarity between the two samples suggests that I am able to control for the aforementioned unobserved factors, such as economic relationships between counties, without losing generality.

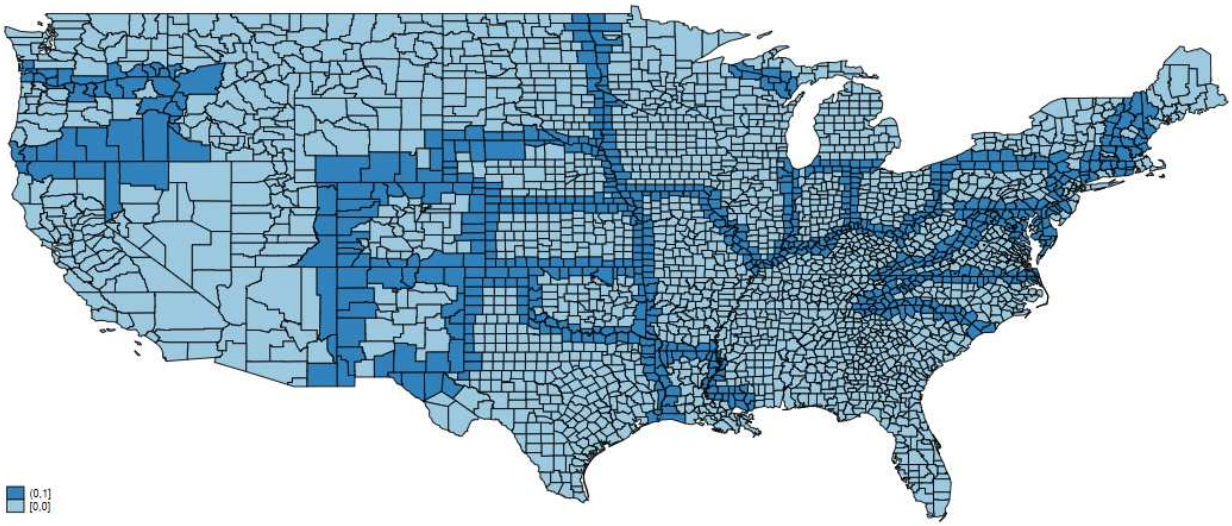

Figure 1.4: Contiguous Cross-Border Counties with a difference in state EITC policy existence

Table 1.1: Summary Statistics for All Counties and Border Counties

	(1)	(2)	(3)	(4)
	All County		Border Counties	
VARIABLES	mean	sd	mean	sd
State EITC Indicator	0.371	0.483	0.486	0.500
State EITC	5.571	10.02	6.102	8.735
Est. Births per 1k	2.048	1.087	2.005	0.942
Est. Expansions per 1k	5.411	2.042	5.494	1.893
Est. Deaths per 1k	2.036	0.974	2.035	0.867
Est. Contractions per 1k	5.374	1.986	5.490	1.825
Non-Employers 1k	67.09	19.81	65.09	17.87
Unemployment Rate	6.503	2.746	6.330	2.642
Existing Establishments	2,055	6,806	1,934	4,844
Med. January Temp.	43.14	13.16	41.27	10.24
Minimum Wage	6.210	1.265	6.266	1.326
Per Capita Income	26,584	7,217	27,098	7,017
Population Density	242.6	1,732	211.7	793.7
State CIT	6.037	2.974	6.389	2.773

Sample means reported for counties over the period 2001-2015

1.5 Empirical Methodology

To establish a baseline, I use first estimate the effect of state Earned Income Tax Credit policies on establishment births using the sample of all counties in the contiguous United States. I estimate:

$$Y_{it} = \beta_0 + \beta_1 EITC_{it} + X_{it}\Gamma + \eta_i + \tau_t + \epsilon_{it} \tag{1.1}$$

where i indexes the counties and t indexes the years. Y_{it} is the outcome of interest. These outcomes include establishment births per 1000 people, establishment deaths per 1000 people, establishment expansions per 1000 people, and establishment contractions per 1000 people. Since existing establishments are also able to capture a portion of the EITC surplus, I also test whether the EITC affects these outcomes which are more relevant for existing establishments.

I examine both the extensive and the intensive margin of the state Earned Income Tax Credit policies. Depending on the regression $EITC_{it}$ is either an indicator for whether a county is in a state with an EITC policy, or it is the the generosity of the state policy represented as a percentage of the federal credit. This allows for the observation of whether the outcomes are affected by just the existence of the state policy or by how generous the policy is.

X_{it} is a matrix of controls. This includes the number of existing establishments, unemployment rate, the minimum wage, per capita income, concentration of professional, scientific and technical services employment, population density, state corporate income tax, and median January temperatures. These variables are used as controls to be consistent with the literature on firm location (Bartik 1985; Guimaraes, Figueiredo, and Woodward 2004; Bunten et al. 2015). I also include county and year fixed effects. The county fixed effects, η_i, control for time-invariant differences across counties such as political ideology and industrial make-up that may affect the outcomes of interest. Year fixed effects, τ_t, are also included to capture national economic conditions that may also affect the outcomes.

My model has some limitations. It implicitly assumes that one county in the United States is as good as any other county, and there are still some unobservable factors that remain even after including county and year fixed effects. I estimate an alternative model the just uses the contiguous cross-border counties that lie along a state border where at some point in the sample period, one state had an EITC policy and the other did not. The use of this sample of counties allows for better comparisons since border counties are more similar to each other than to a random county in the United States. Since businesses do not decide over the full set of counties when determining where to open an establishment, this approach better replicates their decision making process.

In the contiguous cross-border county sample, each county is paired with its neighboring county across the state border. Given that these counties are both geographically and economically related, there are going to be unobserved factors that will affect both counties. These unobserved factors are a potential source of bias. These unobserved factors can be eliminated by differences the differencing the data across the border. Let i denote a county in a state with an EITC policy and j denote county i's cross-border county neighbor and let p denote the pair. Then each county's relationship of EITC to establishment outcomes can be modeled as:

$$Y_{it} = \alpha + \theta_i + \beta EITC_{it} + \lambda_p t + \delta X_{it} + \epsilon_{it} \tag{1.2}$$

$$Y_{jt} = \alpha + \theta_j + \beta EITC_{jt} + \lambda_p t + \delta X_{jt} + \epsilon_{jt} \tag{1.3}$$

θ are the unobserved time-invariant county characteristics, X are the same controls as in the all county sample, and $EITC$ is again either an indicator representing if the county is in a state with an EITC policy or not or the generosity of the policy. $\lambda_p t$ is the pair specific time-varying unobserved factors. By subtracting (3) from (2) these unobserved factors can be eliminated.

$$\Delta_t^p Y_{ipt} = \Delta^p \theta_{ip} + \beta \Delta_t^p EITC_{ipt} + \delta \Delta_t^p X_{ipt} + \Delta_t^p \epsilon_{ipt} \tag{1.4}$$

There still exists pair specific time-invariant unobserved factors in Equation 4. I include pair fixed effects to capture these factors as well as year fixed effects to again capture economic trends that affect all county pairs. The final estimated equation becomes:

$$\Delta_t^p Y_{ipt} = \beta \Delta_t^p EITC_{ipt} + \delta \Delta_t^p X_{ipt} + \eta_{ipt} + \tau_t + \Delta_t^p \epsilon_{ipt} \tag{1.5}$$

The outcomes of interests, $\Delta_t^p Y_{ipt}$ are now in terms of the difference in the number of establishment births, deaths, expansions and contractions per person between the county with the EITC policy and its cross-border neighbor without. The included control variables are the same as in the all county sample but they are also now in terms of the difference between the two counties.

β is still the coefficient of interest, which captures the effect of state Earned Income Tax Credit policies on the difference of establishment births, deaths, expansions, and contractions per person depending on the regression. Given the construction of the contiguous cross-border county sample, there is always one county that is in a state that has a state EITC policy for some duration of the sample period paired with a county that is in a state that never has a state EITC policy during the sample period. This allows for easy interpretation of the EITC variable. It is either an indicator for when the state has such a policy or it is the generosity of the policy for the state with the EITC.

Table 1.2 presents the descriptive statistics for the cross-border differenced summary statistics for the all border county sample and table 1.3 does the same for the sample of border counties where one county enacts the EITC and the paired county never does during the sample period. The means for each of the differenced control variables and outcome variables are small. This indicates that these counties are quite similar in their observable characteristics, making the cross-border counties good controls.

Table 1.2: Summary Statistics for Cross-Border Differences: All Border Counties

Variable	Mean	Std. Dev.	Min.	Max.	N
Diff. Births per 1k	0.041	1.171	-14.664	11.588	18030
Diff. Deaths per 1k	0.052	1.072	-13.529	10.417	18030
Diff. Expansions per 1k	0.14	2.445	-19.935	18.666	18030
Diff. Contractions per 1k	0.153	2.362	-19.266	21.641	18030
Diff. Non-Employers per 1k	1.831	20.298	-127.907	181.819	18030
Diff. in Existence of EITC	0.381	0.508	-1	1	18030
Diff. in Generosity of EITC	6.612	9.532	-15	43	18030
Diff. in med. Jan. Temp	-0.177	2.537	-19	17.8	18030
Diff. in Exist. Estabs. per 1k	0.711	7.816	-56.061	56.76	18030
Diff. in State CIT	0.894	3.822	-10.5	12	18030
Diff in Unemployment Rate	-0.055	2.025	-19.1	12.3	18026
Diff in per capita Income	-143.167	8768.666	-124542.984	124644.953	18030
Diff. in Min. Wage	-0.019	1.011	-4.63	3.55	18030
Diff. in Pop. Densisty	96.645	2741.073	-11149.408	68561.281	18030
Diff. in PSTS Share	-0.334	10.105	-98.876	96.692	18030
Diff. in State Inc. Tax	1.178	4.021	-12	12	18030

Summary statistics reported for the entire study period

Table 1.3: Summary Statistics for Cross-Border Differences: Counties with EITC Paired with Counties without

Variable	Mean	Std. Dev.	Min.	Max.	N
Diff. Births per 1k	0.027	1.072	-5.37	11.588	8085
Diff. Deaths per 1k	0.049	0.997	-5.714	10.417	8085
Diff. Expansions per 1k	0.078	2.385	-9.616	18.666	8085
Diff. Contractions per 1k	0.116	2.308	-10.358	21.641	8085
Diff. Non-Employers per 1k	2.609	20.291	-55.503	181.819	8085
State EITC Indicator	0.758	0.428	0	1	8085
State EITC	9.045	9.409	0	33	8085
Diff. in med. Jan. Temp	-0.143	2.422	-14.5	17.8	8085
Diff. in Exist. Estabs. per 1k	0.708	7.596	-23.21	56.76	8085
Diff. in State CIT	1.722	4.188	-9.99	12	8085
Diff in Unemployment Rate	-0.16	2.089	-12.1	9	8081
Diff in per capita Income	-135.815	6711.71	-49541.488	40736.543	8085
Diff. in Min. Wage	0.145	0.843	-4.4	3.55	8085
Diff. in Pop. Densisty	-81.738	868.899	-11149.408	1825.507	8085
Diff. in PSTS Share	0.22	9.164	-98.876	94.767	8085
Diff. in State Inc. Tax	2.683	3.734	-4.15	11	8085

Summary statistics reported for the entire study period

1.6 Results

1.6.1 All County Results

Table 1.4 presents the results from estimating the effect of the EITC's existence and generosity on the different outcomes of interest using the all-county sample. Five different specifications are reported, one for each of the outcomes of interest: establishment births, establishment deaths, establishment expansions, establishment contractions, and the number of non-employer establishments. Panel A reports the estimated effects of the existences of a state EITC policy, and Panel B estimates the effect of the generosity of the state EITC policy. The standard errors, in parentheses, are calculated according to (Bester, Conley, and Hansen 2011) to account for spatial autocorrelation. I create a continuous grid where each gridcell is 220 by 220 kilometers (2 degrees latitude by 2 degrees longitude). A county belongs to a gridcell if its geographic centroid lies with in that cell and then cluster on these gridcells.

Table 1.4: All-County Sample

	(1) Est. Births per 1k	(2) Est. Deaths per 1k	(3) Est. Expansions per 1k	(4) Est. Contractions per 1k	(5) Non-Employers per 1k
Panel A: Existence					
State EITC Indicator	-0.0262	0.0269	0.0147	-0.0222	0.352
	(0.0202)	(0.0176)	(0.0363)	(0.0253)	(0.363)
Controls	YES	YES	YES	YES	YES
CountyFE	YES	YES	YES	YES	YES
YearFE	YES	YES	YES	YES	YES
N	46134	46134	46134	46134	46134
Panel B: Generosity					
State EITC	-0.00227	0.000604	-0.00304	-0.000734	0.0104
	(0.00152)	(0.00130)	(0.00320)	(0.00196)	(0.0180)
Controls	YES	YES	YES	YES	YES
CountyFE	YES	YES	YES	YES	YES
YearFE	YES	YES	YES	YES	YES
N	46134	46134	46134	46134	46134

County controls include: existing establishments, unemployment rate, minimum wage, real per capita income, concentration of professional, scientific and technical services employment, population density, state corporate income tax, and median January temperatures. Standard errors are clustered at the 220x220km gridcell. *** p<0.01, ** p<0.05, * p<0.1

Counties in states with an Earned Income Tax Credit policy experience fewer establishment births per one thousand people than in counties without such a policy, which is contrary to the hypothesis that the EITC will lower the costs of hiring and make establishment births more frequent, however this result is not statistically significant. Similarly, at the opposite end of the establishment life-cycle the EITC does not appear to prevent establishments from shutting down. This suggests that for the marginal establishment is not able to effectively capture the surplus from the EITC to hire the fire employee and retain the last. The existence of EITC also does not appear to affect the number of hirings and firings at existing establishments.

The results for the generosity of the EITC policies follow a similar pattern with the exception of the number of establishment expansions per one thousand people. Increasing the generosity of the tax credit decreases the number of establishment births, expansions, and contractions as well as increasing the number of establishment deaths and non-employer establishments. Again, none of these results are statistically significant at any conventional levels.

Despite including other factors that partially determine these establishment outcomes, unobserved factors still persist in this sample such as economic interdependence between counties. The all-county sample also assumes that one county chosen at random is as good as a control as any other. This however, is not necessarily the case. These factors may be affecting the accuracy and precision of the estimates. For these reasons, I focus the rest of the analysis on the contiguous cross-border sample.

1.6.2 Contiguous Cross-Border Counties

All Border Counties

Table 1.5 presents the results for the contiguous cross-border for all border counties. This sample of border counties represents the effect of a difference in state EITC policies across a state border. Panel A provides estimates for the difference in the existence in state EITC policies, and Panel B presents estimates for the effect of a difference in generosity between the paired counties.

Table 1.5: Cross-Border Sample: All Border Counties

	(1) Diff. Births per 1k	(2) Diff. Deaths per 1k	(3) Diff. Expansions per 1k	(4) Diff. Contractions per 1k	(5) Diff. Non-Employers per 1k
Panel A: Existence					
Diff. in Existence of EITC	-0.00179	0.00982	-0.0739*	0.000566	-0.229
	(0.0368)	(0.0232)	(0.0435)	(0.0326)	(0.428)
Controls	YES	YES	YES	YES	YES
PairFE	YES	YES	YES	YES	YES
YearFE	YES	YES	YES	YES	YES
N	18026	18026	18026	18026	18026
Panel B: Generosity					
Diff. in Generosity of EITC	-0.000592	-0.000817	-0.00767**	0.00201	-0.0239
	(0.00252)	(0.00156)	(0.00300)	(0.00189)	(0.0290)
Controls	YES	YES	YES	YES	YES
PairFE	YES	YES	YES	YES	YES
YearFE	YES	YES	YES	YES	YES
N	18026	18026	18026	18026	18026

County controls include: existing establishments, unemployment rate, minimum wage, real per capita income, concentration of professional, scientific and technical services employment, population density, state corporate income tax, and median January temperatures. Standard errors are clustered at the 220x220km gridcell. *** p<0.01, ** p<0.05, * p<0.1

As with the all county sample, the existence of a state EITC policy does not appear to increase the births of new establishments or prevent the deaths of existing establishments in counties with the EITC relative to the cross-border counterparts without the EITC. There is evidence that a difference in the existence of state EITC policies causes the difference in the number of establishments per 1,000 people that have an employment expansion to decrease by 0.0739. The effect of the EITC on the difference in expansions is large, 52.8% relative to the mean. Given that these outcomes of interest are positive before differencing, a decrease in the difference either means that the county in the EITC state has fewer establishment expansions, the county in the non-EITC state has more establishment expansions, or both. All cases suggest that for infra-marginal establishments, the existence of state EITC policies makes hiring more employees less attractive.

I find similar results for the effects of the generosity of the state Earned Income Tax Credits. A more generous policy does not increase the number of new establishments or non-employer establishments, or decrease the the number of establishment deaths or contractions. As with the difference in the existence of an EITC policy across state borders the difference in the number of establishments per 1,000 people with an employment expansion decreases as the generosity of state EITC policies increases. For a 10 percentage point increase in the difference in the generosity of the policy, the number of establishment expansions per 1,000 decreases by 0.0767, a 54.8% decrease relative to the mean. An increased difference in the generosity of the EITC policy can represent an expansion of an existing policy becoming more generous than the neighboring policy, or the enactment of a new policy in a state while policy is absent in the neighboring state. The second possibility may explain why the estimates are so similar for both the difference in the existence of the EITC and the difference in the generosity of the EITC policy. Compared to counties in states without an EITC policies or with less generous policies, expanding employment is less attractive because of the generosity of the EITC in the cross-border counterpart. These results suggest that establishments in counties where there is a positive difference in EITC policies (either in existence or generosity) between them and their cross-border counterpart are not able to take advantage of the cost savings associated with the EITC and expand their employment.

Counties with EITC Paired with Counties without

Using the all border county sample sample gives the effects of differences in policies, but does not give the effects of the state EITC polices themselves. This is because cross-border pairs that both are in state with the tax credit (or the policies are equally as generous) look the same in the data as cross-border pairs in states that do not have the credit. This potentially contaminates the comparison category when attempting to estimate the effect of the EITC policy. In Table 1.6, I estimate the effects of the EITC policies by focusing the analysis on the sample of border counties where one county is in a state that enacts an EITC and its cross-border counterpart is in a state that never enacts the credit during the sample period. Panel A presents the results for the effects of the existence of the EITC and Panel B presents the results for the effects of the generosity of the policy.

Table 1.6: Cross-Border Sample: Counties with EITC paired with Counties without EITC

	(1) Diff. Births per 1k	(2) Diff. Deaths per 1k	(3) Diff. Expansions per 1k	(4) Diff. Contractions per 1k	(5) Diff. Non-Employers per 1k
Panel A: Existence					
State EITC Indicator	-0.178***	-0.0680*	-0.193***	0.0181	0.307
	(0.0472)	(0.0362)	(0.0601)	(0.0471)	(0.679)
N	8081	8081	8081	8081	8081
Controls	YES	YES	YES	YES	YES
PairFE	YES	YES	YES	YES	YES
YearFE	YES	YES	YES	YES	YES
Panel B: Generosity					
State EITC	-0.0122**	-0.00428	-0.0190***	0.00279	-0.0313
	(0.00488)	(0.00323)	(0.00517)	(0.00377)	(0.0656)
N	8081	8081	8081	8081	8081
Controls	YES	YES	YES	YES	YES
PairFE	YES	YES	YES	YES	YES
YearFE	YES	YES	YES	YES	YES

County controls include: existing establishments, unemployment rate, minimum wage, real per capita income, concentration of professional, scientific and technical services employment, population density, state corporate income tax, and median January temperatures. Standard errors are clustered at the 220x220km gridcell. *** p<0.01, ** p<0.05, * p<0.1

The effects of the EITC policy is stronger than the effect of a difference in EITC polices, both for the existence of the policy and for the generosity. The EITC causes the difference in establishment births per 1,000 people to decrease by 0.178 between counties in states with the EITC paired with counties in states without the EITC. This effect appears to be small, but considering that these border counties are chosen because they are similar on observable characteristics, these effect are quite large. The decrease in the difference for establishment births per 1,000 people is 659.3% relative to the mean. These results hold for the generosity of the policy as well. Increasing the generosity of the credit by 10 percentage points, decreases the difference in establishment births per 1,000 by 0.122. Increasing the generosity of the credit by 10 percentage points, decreases the difference in establishment births per 1,000 by 0.122, a decrease of about 452% relative to the mean. While both effects are large, the effect for the existence of the EITC on the difference in establishment births is larger, suggesting that the existence of the EITC is more relevant for the establishments seeking to hire their first employee rather than the generosity of the policy. These results suggest that state EITC policies make the transition from non-employer to employer harder relative to counties in state without the tax credit.

I also find that the EITC decreases the difference in establishment expansions per 1,000 people. The existence of a state EITC policy reduces the difference in expansions per 1,000 people by 0.193. This again is a large effect when compared to the mean difference in expansions per 1,000; a decrease of over 247% relative to the mean. Increases in generosity of the policies also reduced the difference in establishment expansions between cross-border counties with the EITC and those without. A 10 percentage point increase reduces the difference in the number of establishments with employment expansions per 1,000 people by 0.190, or 243.6% when compared to the mean difference in expansions. The similarity in magnitudes between the effect of the existence of the EITC and the generosity of the EITC is likely due to the fact that the existence of the policy is the more important margin of the credit for establishments deciding whether to expand or not. For establishments in counties with a state EITC policy, these results suggest that the tax credits are not

reducing employment costs enough to increase employment relative to their cross-border partner with the EITC.

The existence of a state EITC policy also reduced the difference in the number of establishment deaths per 1,000 people between counties in states with an EITC policy and their cross-border counterpart without such a policy. The difference declines by 0.0680 establishments per 1,000 people, though this is only significant at the 10% level. Since establishment deaths per 1,000 is always positive, this result suggests there are more establishment deaths in the county without the EITC policy relative to the county with the EITC. The marginal establishment in counties with the EITC are better able to avoid shutdown when compared to the marginal establishment in counties without the tax credit. Again the existence of the credit is the more important effect for the difference in establishment deaths. The effect of the generosity of the policy is smaller in magnitude and is not statistically significant at any conventional level. The existence of the EITC helps prevent more establishments from shutting down compared to establishments in counties without the EITC meaning that these establishments are able to capture some positive benefit from the implementation of the tax credit.

There is no effect of state Earned Income Tax Credits on the difference in establishment contractions per 1,000 people or the difference in non-employer establishments per 1,000 people. The difference in establishment contractions per 1,000 people is positive for both the existence and the generosity of the EITC, but neither result is statistically significant. Despite the potential for the EITC to reduce employment costs, the causes for employment reductions will still persist. Reducing the salary of existing employees is more challenging than layoffs, so the lack of a result for the effect of the EITC on the difference in employment contractions makes sense. Similarly, the effect of the existence of the EITC and its generosity are not statistically significant on the difference in the number of non-employer establishments. This second set of insignificant results, when combined with the effect of the EITC on the difference in establishment births per 1,000 people, suggests that state EITC policies do little to support new establishments — both employer and non-

employer. For existing establishments, these policies do not affect employment contractions, but they do make employment expansions decrease while also decreasing the number of establishment deaths relative to counties without such policies. Overall, the number of establishments which are hiring — either the first or subsequent employees — declines in counties with the EITC relative to the cross-border counties with a state EITC. Establishments are not able to effectively capture the surplus from these policies to support hiring, but may be able to capture some to avoid shutting down.

1.6.3 Heterogeneous Effects by County Type

Since many of the counties along state borders are larger and more rural, especially in the West, these results may be different for different type of counties. To examine whether there are heterogeneous effects of state EITC policies by type of county, for the treated county, I divide the sample of counties with the EITC paired with counties that never have a state EITC policy into metropolitan counties, micropolitan counties and rural counties. I use the county delineations for metropolitan and micropolitan provided by the Census Bureau for determining which counties belong to which category. A metropolitan county is a county that is part of a metropolitan statistical area — an area with a core of 50,000 or more population. A micropolitan county is similarly defined as a county that is part of a micropolitan statistical area which has an urban core with a population of at least 10,000 people but fewer than 50,000. Any county that is not classified as either metropolitan or micropolitan is classified as rural. These distinctions are likely to be important since the labor market dynamics will be different for each group.

Table 1.7 presents the contiguous cross-border county results for metropolitan, micropolitan, and rural counties. Panels A and B provide the results for metropolitan counties for the existence of a state EITC policy and its generosity respectively. Panels C and D repeat the analyses for micropolitan counties and Panels E and F do the same for rural counties.

Table 1.7: Cross-Border Sample: Counties with EITC paired with Counties without EITC by County Type

	(1) Diff. Births per 1k	(2) Diff. Deaths per 1k	(3) Diff. Expansions per 1k	(4) Diff. Contractions per 1k	(5) Diff. Non-Employers per 1k
Panel A: Metropolitan: Existence					
State EITC Indicator	-0.0255	0.0189	-0.220***	0.0418	1.893*
	(0.0484)	(0.0404)	(0.0681)	(0.0545)	(1.072)
N	2839	2839	2839	2839	2839
Panel B: Metropolitan: Generosity					
State EITC	-0.00185	0.00304	-0.0188***	0.00559	0.00292
	(0.00485)	(0.00367)	(0.00629)	(0.00458)	(0.0907)
N	2839	2839	2839	2839	2839
Panel C: Micropolitan: Existence					
State EITC Indicator	-0.172**	-0.115*	-0.234***	-0.0250	-1.594
	(0.0706)	(0.0689)	(0.0872)	(0.0887)	(1.102)
N	1903	1903	1903	1903	1903
Panel D: Micropolitan: Generosity					
State EITC	-0.0197**	-0.0183**	-0.0240**	0.000259	-0.221*
	(0.00811)	(0.00830)	(0.00926)	(0.0102)	(0.129)
N	1903	1903	1903	1903	1903
Panel E: Rural: Existence					
State EITC Indicator	-0.312***	-0.102	-0.159	0.0407	-0.0610
	(0.0806)	(0.0639)	(0.114)	(0.0869)	(0.704)
N	3339	3339	3339	3339	3339
Panel F: Rural: Generosity					
State EITC	-0.0170**	-0.00377	-0.0164*	0.00377	0.00328
	(0.00822)	(0.00480)	(0.00867)	(0.00689)	(0.0682)
N	3339	3339	3339	3339	3339

County controls are included in every specification. County controls include: existing establishments, unemployment rate, minimum wage, real per capita income, concentration of professional, scientific and technical services employment, population density, state corporate income tax, and median January temperatures. Standard errors are clustered at the 220x220km gridcell. *** p<0.01, ** p<0.05, * p<0.1

There are significant differences in the effects of state EITC policies across the different classifications of counties. The effect of the EITC on the difference in establishment births per 1,000 people is the strongest in rural counties. The existence of an EITC policy in a rural county reduces the difference between it and its cross-border partner without the policy by 0.312 establishments per 1,000 people. Compared to the mean difference in establishment births for rural counties (0.069), this is a reduction of about 452%. For rural counties the bigger factor is the existence of the tax credit. The generosity of the credit also reduces the difference in establishment births. A 10 percentage point increase in the generosity of the credit reduces the difference by 0.17 establishments per 1,000 people, a reduction of about 246% relative to the mean. State Earned Income Tax Credits also significantly reduce the difference in establishment births for micropolitan counties. The existence of a state credit reduces the difference by 0.172 (mean: -0.0014) establishments per 1,000 people. The effect is also strong for increases in generosity of the policy — a 10 percentage point increase in the generosity reduces the number of establishment births per 1,000 people by 0.197. There are no statistically significant effects for metropolitan counties. Since labor markets are generally thicker in metropolitan counties than in micropolitan or rural counties, and hiring the first employee is harder given the associated fixed costs, it makes sense that the effects of the EITC on establishment births are the strongest in those sparser non-metropolitan county labor markets. Thinner labor markets means that there are less opportunities to open a successful establishment, and that pool of potential first employees is smaller. Both of these factors contribute to making hiring the first employee more difficult and resulting in fewer establishment births compared to metropolitan counties.

For the difference in establishment deaths, there is also heterogeneity in the effect of the EITC across the different types of counties. The observed decline in the difference in establishment deaths per 1,000 people from testing the policy effect is driven entirely by metropolitan counties. The existence of a state EITC policy reduces the difference in establishment deaths per 1,000 people by 0.115, a decline of 287.5% relative to the mean difference (-0.040). The effect for micropolitan counties is stronger for the generosity of the policy: a 10 percentage point increase in

the generosity of the policy reduced the difference in establishment deaths by 457.5% relative to the mean. This means that relative to the paired counties, fewer establishments are closing down in counties with the ETIC on average. This result is possibly explained again by the thickness of the labor markets in each of the county classifications. Micropolitan counties may not be large enough or small enough that the marginal establishment has a harder time staying open. These counties are too large to have a high enough degree of monopsonistic competition to keep wages lower, so the cost savings enabled by the EITC make a difference. These counties are also not large enough that there is enough demand for their goods and services to afford the higher wages associated with being in a moderately sized market.

Again, there are differing effects of the EITC by county classification on establishment expansions per 1,000 people. Contrary to the results for establishment births, the effect of state EITC policies on establishment expansions is the strongest in the more populous counties. In metropolitan counties with a state EITC policy, the existence of the credit reduces the difference in establishment expansions per 1,000 people by 0.220 (550% relative to the mean of 0.04). For micropolitan counties the implementation of the EITC reduces the amount of cross-border difference in establishments with employment expansions per 1,000 people by 0.234 (about 100% relative to the mean difference for micropolitan counties of 0.235). The generosity of these policies also matters for all counties. Increasing the generosity of the tax credit by 10 percentage points reduces the difference in establishment expansions per 1,000 people by 0.188 (470%) in metropolitan counties, by 0.240 (102.1%) in micropolitan counties, and by 0.164 (863.2%) in rural counties though the last result is only significant at the 10% level. The impacts primarily being in the metropolitan and micropolitan counties can also be explained by the thickness of labor markets in those counties. Since employment expansions do not have the high fixed costs that are associated with hiring the first employee, expansions are more elastic and the opportunity to expand later is greater, so establishments to do not feel the need to capture the surplus from the EITC in order to expand after its implementation.

Across all categories of counties there are no significant effects of state EITCs on the difference in establishment contractions. The conditions for employment contractions are the same across counties — mismatch of skills, technological change, economy-wide factors, etc. — and these factors are likely to persist despite the potential to save on employment costs by capturing some of the surplus associated with the EITC.

While there were no significant effects of the EITC on the difference in non-employer establishments in the combined sample of counties, when the counties are disaggregated the EITC does affect the difference in non-employer establishments. Implementing a state Earned Income Tax Credit policy increases the difference in non-employer establishments per 1,000 people by 1.893, an increase of nearly 270% relative to the mean (-0.704). At the mean, this increase erases the deficit in non-employer establishments and creates a positive difference between the counties with the EITC and their cross-border counterpart without. This metropolitan county increase in the number of non-employer establishments is consistent with the literature on the EITC increasing the number of self-employed individuals to maximize the amount of their credit (LaLumia 2009; Saez 2010). Micropolitan counties, however, see a decrease in the difference in the number of non-employer establishments as the generosity of state credit increases. A 10 percentage point increase in the generosity of the tax credit reduces the difference in the number of non-employer establishments per 1,000 by 2.21 establishments (153% relative to the mean of -1.44), though this effect is only marginally significant. The thinner labor market in micropolitan counties means that there are less opportunities to begin a successful entrepreneurial endeavor and the more generous state credit may also increase total compensation of the individual making them less likely to start a business and consume more leisure. In the cross-border partner counties, the need to start a non-employer establishment may be greater since there isn't the additional tax credit benefit. The EITC does not significantly affect the difference in non-employer establishments in rural counties. When pooled together these individual effects are masked, but when taken separately the EITC does support some entrepreneurship in certain types of counties.

1.6.4 Potential Mechanisms

Previous research has found that employers are able to capture some of the surplus in the form of paying lower wages to their employees. It would follow that more establishments would be able to use this surplus to hire their first employee or expand their establishment by hiring more employees. I however do not find that this is the case. I find that the EITC causes fewer new establishments to be born and fewer establishments to expand employment relative to their cross-border counterparts. I explore some potential mechanism through which the EITC could affect these outcomes. Table 1.8 tests whether the EITC affects the cross-border difference in state corporate income tax rates, cross-border difference in individual state tax rates, and the cross-border difference in minimum wages. All regressions include the same county controls as in the main analysis.

Table 1.8: Potential Mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)
	Diff. State CIT	Diff. State CIT	Diff. State Income Tax	Diff. State Income Tax	Diff. Minimum Wage	Diff. Minimum Wage
State EITC Indicator	0.502***		-0.557***		-0.145*	
	(0.169)		(0.0770)		(0.0767)	
State EITC		0.0657***		-0.0208***		-0.0134***
		(0.0140)		(0.00677)		(0.00466)
Observations	8081	8081	8081	8081	8081	8081

County controls include: existing establishments, unemployment rate, minimum wage, real per capita income, concentration of professional, scientific and technical services employment, population density, state corporate income tax, and median January temperatures. Standard errors are clustered at the 220x220km gridcell. *** p<0.01, ** p<0.05, * p<0.1

Results in table 1.8 indicate that the EITC has a significant impact on the difference in state corporate income taxes. The existence of a state EITC policy increase the difference in state corporate income taxes by 0.502 percentage points between counties with the EITC and their cross border counterpart that does not. The more generous the credit is the larger the difference in corporate tax rates. A 10 percentage point increase in the EITC increases the difference in corporate tax rate by 0.657 percentage points, suggesting that states increase corporate taxes as a way of funding the more generous EITC policy. This result indicates that corporate income tax rates increase after a state EITC policy is enacted. Since the EITC is a policy that is focused on providing income assistance to low income working individuals and is not designed to provide a surplus to businesses, the EITC is not as salient to establishments as the corporate income tax is. The increased tax rate would discourage establishments from hiring their first or subsequent employees because their costs have increased and can not afford more employees causing fewer establishment births and fewer establishment expansions.

Table 1.8 also shows that the EITC is also significantly correlated with a decrease in the difference between individual state income tax rates. Individual tax rates may be an important factor because many small business pass their profit through to the individual and therefore the individual tax rate may also be a salient factor when deciding to hire employees, especially the first employee since those are smaller establishments by definition. The EITC decreases the difference between cross-border pairs with and without the policy by 0.557 percentage points. Increasing the generosity of the credit by 10 percentage points reduces the difference by 0.208 percentage points. This means that individual tax rates are lower in counties with the EITC relative to counties without. While these effects are significant, they are not necessarily a mechanism through which the EITC functions. The reduction in the difference may be due to the counties in states without the EITC increasing their taxes and reducing the cross-border gap while the EITC treated counties keep their tax rates constant. Even though the difference is decreasing, individuals are not necessarily saving on their taxes which may explain why this decreased difference does not translate into an increased difference in the number of establishments that are hiring.

The minimum wage is another potential mechanism through which observed declines in differences in establishment births and expansions functions. States that are enacting EITC policies may also attempt to help their low income citizens by legislating higher minimum wages at the same time as passing the tax credits, and the higher minimum wage would be more salient for establishments than the EITC. I however do not find this to be the case. The difference in minimum wages between counties with a state EITC and those without decreases by $0.145 after the EITC is enacted. Relative to the mean difference this is a 100% decrease, eliminating any gap between the counties. Similarly, a 10 percentage point increase in the ETIC reduces the difference in minimum wages by $.134 (or 92%). The decline in minimum wages does make sense as a mechanism for a decrease in the difference in the number of establishment births and establishment expansions. The elimination of the average minimum wage gap could be causing workers to be willing to commute across state lines for jobs in counties without the EITC. This is consistent with Shirley (2018) who finds that a $1 minimum wage differential increases the probability of commuting by 0.5 to 1 percentage points. The smaller difference in minimum wages expands the job opportunities for individuals making them more likely to find a job in the county without the EITC. This would increase the number of establishment births and establishment expansions in those counties, thereby reducing the difference in both establishment births and establishment expansions between counties with the EITC and those without.

1.7 Conclusions

In this paper, I use a local identification strategy that takes advantage of differences in state Earned Income Tax Credit policies between pairs of contiguous cross-border counties. This approach addresses omitted variable bias that is caused by spatial trends that affect neighboring counties, as well as better modeling the establishment location selection process.

For contiguous cross-border pairs, the strongest effect of the Earned Income Tax Credit is a decrease in the difference in the number of establishment births and establishment expansions.

The relative declines in the number of establishment births ans expansions is responsive to both the existence of the EITC policy as well as increases in the generosity of the these policies. There is some evidence that the existence of the state tax credit reduces the difference in the relative number of establishment closures as well; this effect does not depend on the generosity of the policy though. These combined results suggest that the state Earned Income Tax Credit policies reduce the amount of hiring for both new and existing establishments, but also helps prevent existing establishments from shutting down.

Since the characteristics of labor markets are different for different county sizes and populations, I examine how the state EITC policies affect different categories of counties by dividing counties into metropolitan, micropolitan, and rural contiguous cross-border counties. The declines in the number of establishment, births, expansions, and deaths are primarily driven by the micropolitan and rural counties, with the largest effects coming from the rural counties. These findings suggest that there is limited effectiveness in using state EITC policies to increase labor demand in rural counties.

On the surface, these results appear counterintuitive. Previous research has shown that employers are able to capture a portion of the EITC surplus by paying their employees lower wages. This would seem to suggest that employers would want to lower their wage bill by locating in counties in states with an Earned Income Tax Credit policy and even more would locate in states with a more generous state policy. This would also make it more likely that these counties would have more establishments with employment expansions since hiring an additional worker in now less expensive. However, this is not what occurs. I explore some potential mechanisms and find that the EITC is correlated with an increased corporate income tax differential and a decreased minimum wage differential. Since corporate taxes may be increasing to fund the EITC policies, and these are plausibly more salient to establishment owners, these could be a reason for the observed decrease in the difference in establishment births and expansions. The increase in the minimum wage dif-

ferential may also account for some of the decline in these outcomes due to workers commuting across state lines due to the increased minimum wage.

The labor supply effects of the the Earned Income Tax Credit are well documented: individuals increase their labor force participation following expansions of the tax credit. This works suggests that, at least for state EITC policies, there is a trade off between the increased labor supply effect of the EITC and a decline in labor demand. This trade off suggests that state EITC policies may be limited in their effectiveness to increase entrepreneurship and help struggling regions.

More research is needed to fully understand the effects of the Earned Income Tax Credit on new establishment births and expansions. Future research should consider how the timing of the EITC affects these decisions and whether the negative effects found in this paper are persistent over time. The EITC may not be relevant for all types of workers. Future research should consider whether certain industries are more affected by the enactment of the tax credit than others.

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Chapter 2

The Long-Term Impacts of the Earned Income Tax Credit on Entrepreneurship

2.1 Introduction

The Earned Income Tax Credit (EITC) is one of the largest anti-poverty measures in the United States. This tax credit is designed to help low- to moderate-income individuals and families by supplementing their incomes while encouraging work. In 2021, 25 million tax filers received the credit totaling about $60 billion (*EITC Fast Facts* 2020). The average amount of the federal tax credit received in 2021 was about $2,411 (*EITC Fast Facts* 2020). The recipient of the tax credit is not the only person in the household that is affected by the credit. The children of recipients also stand to benefit from these additional resources. Since there is no limit on the number of years that a tax filer can file for this credit, this potentially represents a significant increase in family resources over the duration of childhood, for those who qualify. The additional resources from the tax credit can impact outcomes for the children both during childhood, when the credit is received, as well as outcomes as an adult.

One of the long-term outcomes that may be affected by increased resources from the EITC is entrepreneurship as an adult. This paper tests whether increases in childhood EITC benefits affects the likelihood of becoming an entrepreneur as an adult. The EITC may impact adult entrepreneurship outcomes for the children of the recipients due to how the tax credit is structured. This structure opens two possible pathways for exposure to affect future entrepreneurial outcomes that are in tension with each other: the resource effect and the demonstration effect. In order to receive the credit, individual must be working. The income from employment as well as the supplemental income from the tax credit will increase family resources, which may affect the attitudes and preferences of the children as well as providing better opportunities for the children which

may combine to lead them to avoid entrepreneurship. Another way the design of the EITC can affect entrepreneurial outcomes of the children is that the work requirement attached to the credit can be satisfied through self-employment. A parent may become self-employed in order to receive the benefits of the credit, which will then provide an example of entrepreneurship for the child, potentially increasing their likelihood of becoming an entrepreneur as an adult. This paper will test which of these two effects is the dominant effect of the EITC on future entrepreneurial outcomes.

This paper makes important contributions to the literature on the effects of the EITC. First, I extend the literature on how the EITC affects entrepreneurship and how the EITC affects the outcomes of children, by estimating the impacts of the EITC on the entrepreneurial outcomes of the children of EITC recipients. The existing literature on how the EITC affects entrepreneurship has focused on the entrepreneurial decisions of the recipients. Additionally, the literature on the impacts of the EITC on children has not focused on their adult entrepreneurial outcomes. This paper is able to fill in some of the gaps in both of these important strains of EITC literature.

Second, this paper examines another important outcome that the existing EITC literature has not yet investigated: risk preferences. I use rich survey data which includes measures of childhood risk preferences and test whether increases in the Earned Income Tax Credit impact these measures of risk. Understanding these preferences are important to better understanding future entrepreneurial outcomes because becoming an entrepreneur involves an inherent amount of risk.

Lastly, this paper contributes to the literature by examining whether the timing of increases in the EITC (and therefore family income) matters for long-term entrepreneurial outcomes. I am able to observe the amount of EITC exposure for each individual in my sample during each year of childhood. I use test if there are differing effects on EITC increases by difference age periods to better understand when the EITC has the greatest impact on adult entrepreneurship.

I exploit variation in the timing of EITC policies, changes in family composition, and variation in state policy to create a measure of childhood EITC exposure to test the impact of the Earned Income Tax Credit's effect on the likelihood of the child becoming an entrepreneur as an adult. This measure of EITC exposure is created in the same way as Bastian and Michelmore (2018). EITC exposure is calculated based on when the child is born because this determines which EITC expansions they are subject to, the number of children in the household, and the state of residence since states can also pass their own version of the EITC to supplement the federal credit. This measure of EITC exposure is used instead of actual possible EITC amounts to avoid potential endogeneity between income and the decision to become an entrepreneur. This is calculated for each year of childhood from birth to age 18, and each year of exposure is summed into a single measure of total childhood exposure. I use this measure to estimate the causal effect of EITC on adult entrepreneurial outcomes.

I use two different outcomes to measure entrepreneurship as an adult: self-employment and business ownership. These outcomes both represent different aspects of entrepreneurship. Self-employment is representative of entrepreneurship-by-necessity, which is often lower productivity and less growth oriented. Business ownership is more akin to entrepreneurship-by-opportunity and is associated with higher productivity projects and is more growth oriented. By using these two outcomes, I am able to test for how the EITC impacts each type of entrepreneurial endeavor.

Results indicate that an increase in the generosity of the EITC does impact entrepreneurship outcomes in adulthood for the children of the recipients. I find that increases in the EITC increase the likelihood of being a business owner, but have no effect on the likelihood of being self-employed as an adult. A $1,000 increase in total EITC exposure increases the likelihood of being a business owner by 2.5-2.8%. The impact of the EITC is strongest for the families with the lowest incomes, who the exact families that are the most likely to be impacted by changes in the EITC policy. Contrary to Bastian and Michelmore (2018) and Braga, Blavin, and Gangopadhyaya (2020), I do not find any impacts of the timing of increases in EITC exposure on adult business ownership.

I also examine whether there are differing impacts for different sub-populations of the sample. I find that increases in EITC exposure increase the likelihood of being a business owner in adulthood for females and for the children of parents without a bachelor's degree. Increasing the total EITC exposure by $1,000 increases the likelihood of owning a business as an adult by 5% and 3%, respectively. The impacts for these sub-populations overlap with the most affected sub-populations in Bastian and Michelmore (2018) and Braga, Blavin, and Gangopadhyaya (2020).

I then explore some possible mechanisms for how the EITC may affect future entrepreneurship. I first test whether there is a demonstration affect by focusing on the adult outcomes of children who have entrepreneurial parents. I do not find any evidence for a demonstration effect from the EITC. Next I explore how the EITC impacts the preferences for risk since risk tolerance is a determinant of entrepreneurship. I do find that increased resources reduces the likelihood of having a higher preference for risk. A $1,000 increase reduces the likelihood of higher risk tolerance by 0.95%. Here I do find difference impacts by the age of EITC exposure. Reductions are greater for increased exposure during the ages 13 to 18. These results combined with the previous results for the children of entrepreneurs and the results on self-employment as an outcome suggest that the resources effect is the dominant effect.

This paper provides further evidence for the positive impacts of the EITC on children from low-income families in addition to the adult recipients. These findings have important implications for entrepreneurial policy suggesting that the additional resources provided by the EITC improves the likelihood of higher-quality entrepreneurship in adulthood. These results may have important implications for intergenerational inequality as I find the largest effects for the children from the lowest income families.

The rest of the paper proceeds as follows. Section 2 reviews the relevant previous literature. Section 3 describes the data and the construction of the final sample. Section 4 outlines the empirical methodology. Section 5 presents the main results of the paper, including potential mechanisms, and section 6 concludes.

2.2 Previous Literature

There exists a growing literature on the effects of the EITC on children of recipients. Much of this literature focuses on the contemporaneous effects receiving the credit. One of the effects researchers have examined is how the EITC affects student achievement outcomes. Dahl and Lochner (2012) wanted to estimate the effect of changes in family income on the educational outcomes of the children. However, changes in family income are often endogenous with student achievement. For example an increase income could change parenting behavior or the amount of time the parent is able to spend with children, affecting scholastic achievement. To overcome this endogeneity issue the authors use policy changes in the EITC as an instrument for changes in family income. The change in policy from the 1993 expansion to the 1997 expansion amounted to a $2,100 increase in payments. They find that a $1,000 increase in EITC benefits received causes a 6% increase of a standard deviation in math and reading scores (Dahl and Lochner 2012). This is an important impact of expansions of the EITC, but this is only a short term effect. From this research we do not know how the EITC affect children over the long term. My research will contribute to the literature by examining different outcomes for the children of families who receive the EITC as well as examining the long term impacts of the EITC on children.

The EITC has been used to estimate the effects of increases in cash-on-hand on college enrollment as well (Manoli and Turner 2018). The idea behind the cash-on-hand hypothesis is that families with more available family funds around the time that college enrollment decisions are made (spring of the senior year of high school) will increase the number of enrollees. Instead of using expansions of the federal EITC policy Manoli and Turner (2018) take advantage of how the EITC credit is structured. They use the nonlinearities in the credit structure to estimate how increases in cash-on-hand, via increases in the EITC around the kink, affects subsequent college enrollment. They find that increase in the EITC also induces a 1.3% increase in the likelihood of enrolling in college for children in the spring semester of their senior year of high school (Manoli

and Turner 2018). This again is an educational outcome, but education is potentially one of the mechanisms that affects risk preferences and entrepreneurial behavior.

Contemporaneous health outcomes of the children of benefit recipients are also impacted by the EITC. One of the standard measures of infant health is the incidence of low birth weight. This measure is highly predictive of longer term adult health and economic outcomes. The 1993 expansion of the EITC reduced the incidence of the low infant birth weight by 0.17-0.31 percentage points, a 1.6-2.9% decline in th population Hoynes, Miller, and Simon (2015). This shows that the impacts of the EITC are not just economic, but that they affect health as well and may also affect different behavioral patterns as well such as preference for risk. The current work will also utilize EITC expansions as well as other sources of variation in EITC benefits such as family composition.

While much of the research on the effects of the EITC on children of the recipients focuses on contemporaneous effects, research is beginning to examine longer term effects. The EITC has been shown to increase the likelihood of graduating high school, completing college, and being employed as an adult (Bastian and Michelmore 2018). Bastian and Michelmore (2018) also find that increased exposure to the EITC also increases adult earnings 2.2%. They divide the childhood into different sub-periods and find that increases in EITC during the teenage years is more important that increases in earlier periods of childhood. This is consistent with the cash-on-hand hypothesis of Manoli and Turner (2018). The EITC also has long term impacts on the health of children of recipients. A 3% increase in EITC exposure increases the likelihood of reporting being in good health and decreases obesity by 4.1% as an adult (Braga, Blavin, and Gangopadhyaya 2020) My work will contribute to this growing literature on the long term effects of the EITC on children of recipients and similar to Bastian and Michelmore (2018) I will also examine when in childhood are increases in EITC benefits the most beneficial.

The impacts on the recipients of the EITC are also important to consider, since these effects can be a mechanism that affect the children as well. The EITC increases the labor supply of single

mothers, potentially meaning that less time is being spent with their children (Eissa and Liebman 1996; Meyer and Rosenbaum 2001; Schanzenbach et al. 2020). This could then impact the child's preferences for risk and the likelihood of future entrepreneurship.

The EITC can also increase self-employment. Given the design of the tax credit, expansion in generosity is predicted to increase the amount of reported self-employment income in the phase-in region and decrease it on the phase-out region. Given the way the EITC is structured, people use self-employment to maximize the amount of credit they receive (Saez 2010). Both LaLumia (2009) and Chetty, Friedman, and Saez (2013) find that the EITC increases self-employment. Expansions in federal EITC policy increases the likelihood of reporting self-employment income for unmarried filers by 3.2% and by 4.1% for married filers (LaLumia 2009). This shows that the EITC does increase entrepreneurship for those who receive the credit which may also affect the entrepreneurial behaviors of the children. Chetty, Friedman, and Saez (2013) use changes in family composition as their identification strategy to show that in areas with more EITC filers individuals increase their reported self-employment income relative to areas with fewer EITC filers. The amount of time spent on self-employment increases for low-income non-college educated married mothers following an increase in state EITC benefits (Lim and Michelmore 2018). This could be another channel through which the EITC affects risk preferences of the children. This shows that differing EITC policies could lead to entrepreneurial hot spots which could spur children to start their own projects as adults. Instead of focusing on the entrepreneurial decisions of the recipients I will contribute to the literature by focusing on the entrepreneurial decisions of the children of recipients.

Self-employment is one type of entrepreneurship. There are other entrepreneurial outcomes that are also worth considering. In addition to self-employment, I also examine how the EITC affects business ownership because self-employment is associated with entrepreneurship by necessity and is often lower productivity than other types of entrepreneurship (like business ownership). The self-employed are more likely to enter self-employment after experiencing unemployment rather

than coming from wage and salary work (Evans and Leighton 1990). Self-employment rates also increase during recessions when wage and salary jobs are more scare and decrease during expansions when they are more plentiful (Fossen 2021). This suggests that those choosing to become self-employed needed to do so because they did not have other wage and salary options. While self-employment is a good way for individuals to continue to work after experiencing unemployment, it may not help spur innovation in the wider economy since these new business are of lower productivity (Fossen 2021). Further, those who went into self-employment experience a lower drop in earnings than those who end their unemployment spell by returning to wage and salary work (Evans and Leighton 1990) also shows that these endeavors are not as productive as other opportunities. This can create adverse selection in who becomes self-employed versus those business owners that are both more productive and hire more employees, contributing more to overall growth (Belitski and Korosteleva 2010; Burke, Lyalkov, and Millán 2021). By examining both types of outcomes, I am able to test which type of entrepreneurship the EITC encourages.

This work also contributes to the literature on the determinants of entrepreneurship. One of the largest factors for why an individual becomes and entrepreneur is whether or not they have entrepreneurial parents. While this is widely known and accepted, the origins of such behavior are not known. Using Swedish adoption records, which contain information on the child and all four parents, Lindquist, Sol, and Van Praag (2015) find that the likelihood of a child becoming an entrepreneur increases by about 60% if one of their parents is an entrepreneur. Taking advantage of their unique data, they show that pre-birth factors are important in becoming an entrepreneur, but that post-birth factors are twice as important (Lindquist, Sol, and Van Praag 2015). This shows that the modeled behavior is important in becoming an entrepreneur, and suggests that the increase in likelihood of parents due the the EITC could be an important determinant for the entrepreneurship of the child. Exposure to innovation is also an important determinant of who becomes and inventor. Growing up in a high-innovation area increases the chance of a child becoming an inventor later in life (Bell et al. 2019). Risk preferences are also an important determinant of becoming an entrepreneur and a two standard deviation in the willingness to take risks increases the prob-

ability of being self-employed by 5-6% (Skriabikova, Dohmen, and Kriechel 2014). While this is obvious it is difficult to test because of confounding environmental factors such as parental entrepreneurship. Skriabikova, Dohmen, and Kriechel (2014) use a sample of the Ukrainian population whose parents grew up during the Soviet period because entrepreneurship was banned. With no entrepreneurial role models for parents, the effect of risk could be isolated. The labor market conditions of a location also influence the behavior of entrepreneurs and would-be entrepreneurs. When there is high wage and salary volatility, more people become self-employed because people want to minimize the amount of risk that they face in the labor market (Low and Weiler 2012). The EITC may change the risk preferences of individuals as well which would then influence subsequent entrepreneurship.

2.3 Data and Sample

Data come from the National Longitudinal Survey of Youth 1979 (NLSY79) sample. The NLSY79 is a nationally representative sample of non-institutionalized individuals who were ages 14 to 22 in 1979. The original sample of individuals has been followed and surveyed annually through 1994 and biannually thereafter. The sample originally included 12,686 young men an women, and there are currently 9,964 eligible respondents remaining in the survey. Beginning in 1986, a supplemental survey, the National Longitudinal Survey of Youth 1979 Child and Young Adult (NLSYCYA), was conducted to gather information on all children born to women in the NLSY79. As of the latest round of the survey there were 11,545 children born mothers from the NLSY79. These data from NLSYCYA combined with the NLSY79 contain a rich set of information on individual and family characteristics, which are used to calculate the annual exposure to the EITC.

I limit the sample to the children of mothers from NLSY79 who are at least age 25 by 2016, which is the age at which outcomes are first measured. The sample is further restricted to the children who are observed throughout childhood up to age 18 with full information for the children

and their mothers. These restrictions reduce the sample to 1,904 individuals born between 1984 and 1991.

Summary statistics are presented in table 2.1. All dollar values are adjusted for inflation with the Consumer Price Index and reported in 2016 dollars. The mothers of the individuals in the sample have completed some college average which is a similar level of average educational attainment for the individuals themselves. Most of the individuals grew up in households with married parents and have an average of 1.7 siblings. About 12% of individuals in the sample have a mother who considers themselves an entrepreneur and around 13% have a parent who owns a business. The average cumulative maximum EITC benefits from a child's birth to age 18 were approximately $34,000. On average, individuals were exposed to greater EITC benefits between the ages 13 and 18 ($15,479) than between birth and age 5 ($4,101). This disparity is partially explained by the fact the largest expansions of the EITC occurred after the majority of the sample turned 5. Only the very youngest individuals in the sample would have been under 5 during the largest expansions in the early 1990s. Another contributing factor in the difference in maximum EITC exposure between 0-5 and the older age groups is that children under 6 are less likely to have other siblings in the household. Approximately 35% of the 0-5-year-olds in my sample have no other siblings in the household, compared to around 21% of 6-12-year-olds. The 13-18 year-olds are about as likely to have no other siblings in the households, but are more likely to have at least another sibling in the household.

2.4 Empirical Methodology

To analyze how the EITC affects entrepreneurial outcomes as an adult, I follow the methodology of Bastian and Michelmore (2018) and create a measure of EITC exposure during childhood. EITC exposure is defined as the maximum potential federal and state credit that the child's family could receive given the tax year, state of residence, and number of children in the household. This calculation was made independent of parental marital status or actual family income. The

Table 2.1: Descriptive Statistics of Sample

Variable	Mean	Std. Dev.
Female	0.514	0.5
Black	0.261	0.439
Hispanic	0.208	0.406
Siblings	1.7	1.168
Highest Grade Completed	13.444	2.211
Parents Married	0.651	0.477
Mother's Highest Grade Completed	13.973	2.471
Parent Business Owner	0.132	0.339
Parent Entrepreneur	0.122	0.328
Total EITC Exposure ($000s)	33.999	7.835
EITC Exposure Age 0-5 ($000s)	4.101	1.973
EITC Exposure Age 6-12 ($000s)	14.418	4.082
EITC Exposure Age 13-18 ($000s)	15.479	3.374
Observations	1904	

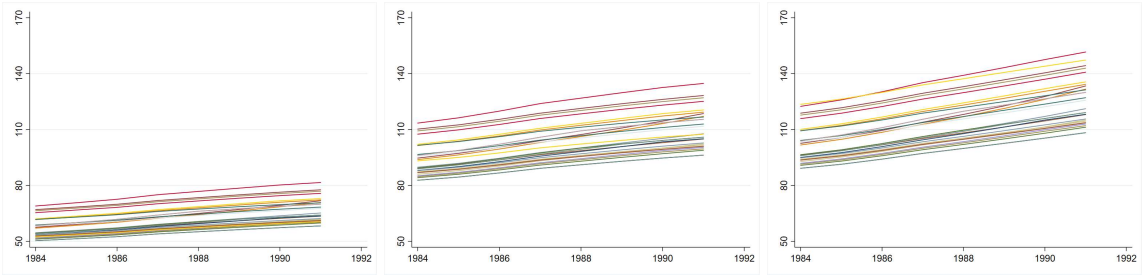
Children born between 1984 and 1991 who meet the following criteria: observed each wave of the National Longitudinal Survey of Youth Child and Young Adult between the ages 0 and 18, turn 25 by 2016, have full information for each of the controld variables including the risk assessment. All dollar measures are in 2016 dollars. Earned Income Tax Credit (EITC) exposure is defined as the maximum potential federal and state EITCa household could receive, given the year, state, and number of children in the household.

total amount of EITC exposure is summed, for each individual, from an individual's birth until they turn 18 or the last year they reside in the parents' household, whichever comes first. The amount of EITC exposure each individual receives is not constant over time due to state and federal EITC policy changes, changes in family composition, as well as moving across state lines. As an example, an individual who is the firstborn child in a household will have the maximum federal and state EITC available for a household in the year in which there were born and in the state that they were born. In the next year, if a sibling enters the household, both children will be assigned the maximum federal and state EITC possible for a two-child household in that state after the birth of the second child. This will remain the case, as long as the family size does not change, until the first child turns 19. At that point, the second child will be assigned the maximum federal and state EITC available for that year, in that state for a one-child household until they turn 19 or leave the household, whichever comes first.

There are three main sources of variation in maximum potential EITC exposure: the year the individual was born, the state in which the individual was lives, and the number of children in the household. The year of birth determines the amount of federal EITC credit to which the individual is exposed based on expansions of the federal policy. While there are policy changes in the state level EITC policies, those changes are much smaller than the impact of the federal expansions the EITC undergoes over time. The state of residence of the individual determines whether there is a supplemental state-level credit that the family could have received. Lastly, the number children determines the maximum amount the household is eligible for since the credit becomes more generous with more children living in the household.

This measure of EITC exposure is used, instead of actual EITC benefits for which the family is eligible to avoid concerns of endogeneity between family income and actual EITC benefits with respect to entrepreneurial outcomes. To be eligible for the EITC, families must have an income below a certain threshold, which was $53,505 in 2016. Thus, income in negatively correlated with EITC eligibility. Individuals with higher levels of EITC benefits are likely to be disadvantaged in other ways too, which may affect their future entrepreneurial decisions. They may live in worse neighborhoods, attend worse schools, grow up in single parent households, worse nutrition, which all may affect their decision and need to become an entrepreneur. So increases in actual EITC benefits, will likely also reflect changes in some of these other disadvantages as well. Using the EITC exposure during an individual's childhood rather than the actual EITC benefits for which the family is eligible, will help isolate the plausibly exogenous policy variation and exclude the endogenous variation in EITC eligibility.

Figure 2.1 simulates the variation in EITC exposure a child could potentially receive from birth to age 18 by birth year, state, and the number of children in the household. This was constructed by summing the maximum amount of federal and state EITC available in each year since birth to age 18 for each of the states that have a state-level policy as well as just the federal EITC amounts for the states without such a policy (the bottom line in each panel) for the households with one, two



(a) **(b)** **(c)**

Figure 2.1: Maximum Federal + State EITC Benefits (1000s of 2016 Dollars)

Maximum possible federal and state Earned Income Tax Credit exposure possible from birth to age 18 by birth year and state. EITC exposure is defined as the maximum potential federal and state EITC an individual could receive in a given year and state for a one- (a), two- (b), or three-plus-child (c) household. The lowest line in every panel represents the maximum federal EITC exposure for states with no state-level policy

or three-plus children. The figure shows what EITC exposure would look like for children born between 1984 and 1991 if they lived in a one-, two-, or three-plus-child household for their entire childhood assuming that they never move out of their state of birth. The results of this exercise demonstrate that there is substantial variation in the amount of EITC exposure, depending on birth year and state of residence. Individuals born in 1984 could have been exposed up to about $69,000 for a one-child household and up to $123,000 for a three-plus-child household. For children born at the end of the sample these values increase to over $81,000 and $151,000 respectively.

Figure 2.2 shows how the simulated variation in EITC exposure translates into actual EITC exposure between birth and age 18 for the sample. Figure 2.2 represents nearly 700 unique values of EITC exposure for the sample of 1904 individuals and reflects any changes in household size as well as any cross-state moves an individual experiences between birth and age 18. There is wide variation in the amount of EITC exposure which is consistent with the simulated values represented in figure 2.1. The variation in figure 2.2 ranges from less than $17,000 for individuals born between 1984 and 1985 and over $68,000 for individuals born between 1989 and 1991. Since there is a work requirement attached to the receipt of the EITC, these individuals also experienced increases in family earnings in addition to the tax credit. As a result, the EITC had a large impact

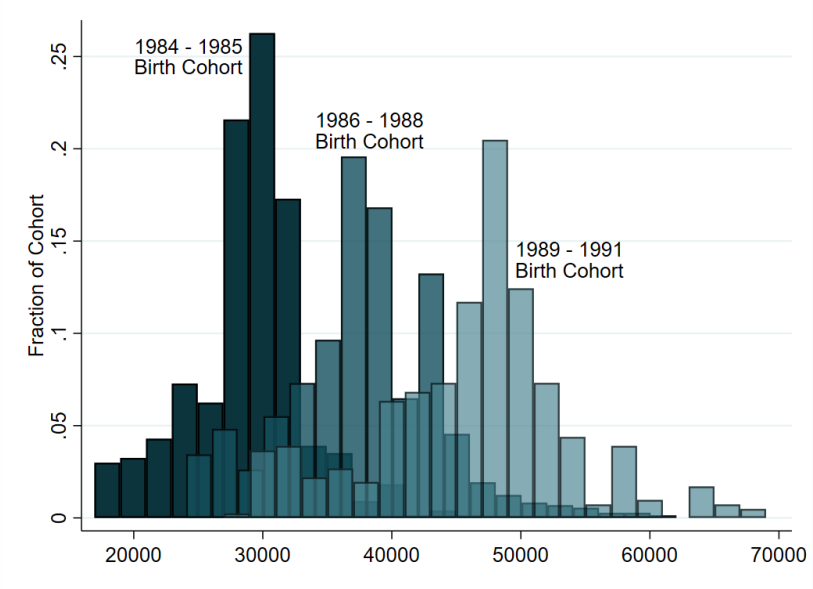


Figure 2.2: Total EITC Exposure from Birth to 18 (2016 Dollars)

Distribution of total EITC exposure from birth to age 18. EITC exposure is shown in 2016 dollars and is defined as the maximum potential federal and state EITC an individual could have received in a given year, state, and number of children in the household. The histogram reflects 694 unique values for 1904 individuals.

on household resources for many of the children growing up in low-income families over this time period.

To analyze the effect of the EITC on entrepreneurial outcomes, I estimate the reduced-form effect of increasing EITC exposure during childhood on adult entrepreneurial outcomes. The EITC has the potential to affect adult entrepreneurial outcomes through two possible avenues. One possible path for childhood EITC benefits to affect future entrepreneurship is by increasing the amount of resources available for the family. This “resource effect" may reduce the child’s preference for risk and allow for more productive opportunities, decreasing the likelihood of future entrepreneurship. An alternative path for the EITC to affect future entrepreneurship is through the entrepreneurial decisions of the parents. Since one of the ways to satisfy the work requirement of the EITC is through self-employment, increases in EITC may induce more parents to become entrepreneurs themselves, which provides an example of entrepreneurship for their chil-

dren. This “demonstration effect" would increase the child’s likelihood of future entrepreneurship. If the resource effect dominates, then increasing EITC exposure during childhood will reduce the likelihood of future entrepreneurship. If the demonstration effect dominates, I would expect the opposite. To test these hypotheses, I estimate the following:

$$Y_i = \beta_0 + \beta_1 EITC_i + \gamma X_i + \psi V_s + \pi Z_s + \eta W_t + \epsilon_i \tag{2.1}$$

where i indexes individuals, s indexes states, and t indexes years. Here Y_i is the outcome of interest: the individual has ever been self-employed, and the individual has ever been a business owner. All outcomes are measured at age 25 and at age 35. Using both 25 and 35 for measuring allows me to assess whether the EITC has a more immediate impact on becoming an entrepreneur or if it impacts entrepreneurship in later adulthood. Later adulthood is of interest because most successful entrepreneurs become an an entrepreneur at about age 45 (Azoulay et al. 2020). Since only the absolute oldest individuals initially in the NLSYCYA would be 45 in 2016, I focus on outcomes at age 35. By using both self-employment and business ownership, I will be test for differences in types of entrepreneurship. While both measures are similar, there are important differences. Self-employed individuals are more likely to be less growth oriented, not as productive as employer firms, and more likely to be entrepreneurs out of necessity than opportunity. Individuals who report owning a business are more likely to have employees, be more growth oriented than a sole proprietorship, and are more likely to be entrepreneurs of opportunity that self-employed individuals. β_1 is the coefficient of interest, which represents the impacts of an additional \$1,000 of EITC exposure during childhood on subsequent entrepreneurial outcomes.

The term X_i represents a vector of personal characteristics that includes parental marital status at age 18, highest grade completed by the mother, number of siblings at age 18, marital status at age of entrepreneurship, indicators for female, black, Hispanic, homeownership at entrepreneurship and health insurance at age of entrepreneurship, birth year fixed effects, and entrepreneurship year

fixed effects. These controls account for changes in entrepreneurship over time that vary by race, gender, individual and family characteristics that correlate with future entrepreneurship.

The term V_s is a vector of state-by-year policy and economic variables such as state per capita GDP, state minimum wage, and state unemployment rate. Each variable is measured at the time the individual first becomes an entrepreneur. For the individuals who never become entrepreneurs, these variables are measured at the average age at which the entrepreneurs in the sample become entrepreneurs [1]. These controls are to account for the economic and policy environment which may influence the individual's decision to become an entrepreneur. State-specific time trends are also included to account for further unaccounted for policies or conditions that vary by state across time. The terms Z_s and W_t are indicators for the state and the year in which the individual may become an entrepreneur, respectively, and ϵ_i is an idiosyncratic error term. To account for unobserved correlation of the error terms within states, standard errors are clustered at the sate level.

2.5 Results

2.5.1 EITC Exposure and Adult Entrepreneurship

Table 2.2 presents the results from estimating the effect of childhood EITC exposure on whether the individual becomes self-employed as an adult. This outcome is measured at both age 25 (columns 1 and 3) and at age 35 (columns 2 and 4) to allow for the possibility of entrepreneurship in early adulthood and later in adulthood. Columns 3 and 4 divide total EITC exposure in to exposure for three different age brackets: 0-5, 6-12, and 13-18. This is done to test whether there is a differential effect of the timing of EITC exposure on adult self-employment.

Results suggest that there is little effect of total EITC exposure on the likelihood of future self-employment. Increasing total EITC exposure during childhood reduces the likelihood of self-employment at both age 25 and 35, but neither result is statistically significant. Similarly, in

[1] The median age of entrepreneurs was also tested, but the median age of entrepreneurship was not significantly different from the mean age.

Table 2.2: Effect of Earned Income Tax Credit (EITC) Exposure on Self-Employment

	(1) Self-Employed by Age 25	(2) Self-Employed by Age 25	(3) Self-Employed by age 35	(4) Self-Employed by age 35
Total EITC Exposure ($000s)	-0.00147		-0.00154	
	(0.00130)		(0.00126)	
EITC Exposure Age 0-5 ($000s)		-0.0106		-0.0128
		(0.0196)		(0.0187)
EITC Exposure Age 6-12 ($000s)		0.00381		0.00393
		(0.00509)		(0.00430)
EITC Exposure Age 13-18 ($000s)		-0.00357		-0.00362
		(0.00314)		(0.00289)
Observations	1904	1904	1904	1904
R^2	0.115	0.116	0.375	0.375

EITC exposure is defined as the maximum potential federal and state EITCa household could receive, given the year, state, and number of children in the household. Results reflect the estimation of equation (1) and include demographic controls; state-year controls at the age of self-employment; indicators for state of residence at time of self-employment, year of birth, and year of self-employment; and state-specific quadratic time trends. For individuals that did not become self-employed, control variables are taken at the average age of self-employment. Standard errors (in parentheses) are clustered at the state level. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$

columns 3 and 4, I find little effect of increasing EITC exposure during specific points in childhood. None of the coefficients on the EITC exposure variables are statistically significant from 0. These results suggest that increasing EITC exposure at different developmental stages has no effect on future self-employment.

These results imply that there is not much evidence of the "demonstration effect" for an increase in childhood EITC exposure. The demonstration effect hypothesis is that increases in EITC induces the parents to become self-employed to satisfy the work requirement attached to the EITC. This increase in self-employment by the parents, in turn, provides an example for the children and increases their likelihood of becoming self-employed as adults. For the results to be consistent with this hypothesis, the coefficient on EITC exposure would need to be significantly greater than 0. I instead find no increase in adult self-employment. It is possible that the demonstration effect exists for some individuals, but the "resource effect" for other individuals erases some of those effects on average. Since it is unclear which effect is present from these results, I further test the impacts of increased EITC exposure on the risk preferences of the child in section 5.2.

Table 2.3: Effect of Earned Income Tax Credit (EITC) Exposure on Business Ownership

	(1) Business Owner by age 25	(2) Business Owner by age 25	(3) Business Owner by age 35	(4) Business Owner by age 35
Total EITC Exposure ($000s)	0.00310**		0.00327**	
	(0.00139)		(0.00136)	
EITC Exposure Age 0-5 ($000s)		0.0154		0.0174
		(0.0316)		(0.0317)
EITC Exposure Age 6-12 ($000s)		0.00707		0.00644
		(0.00647)		(0.00638)
EITC Exposure Age 13-18 ($000s)		0.000525		0.000985
		(0.00252)		(0.00241)
Observations	1903	1903	1903	1903
R^2	0.106	0.107	0.251	0.252

EITC exposure is defined as the maximum potential federal and state EITCa household could receive, given the year, state, and number of children in the household. Results reflect the estimation of equation (1) and include demographic controls; state-year controls at the age of business ownership; indicators for state of residence at time of business ownership, year of birth, and year of business ownership; and state-specific quadratic time trends. For individuals that did not become business owners, control variables are taken at the average age of business ownership. Standard errors (in parentheses) are clustered at the state level. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$

Table 2.3 presents the results for the other outcome of interest: whether an individual was ever a business owner. This is again measured at age 25 (columns 1 and 3) and at age 35 (columns 2 and 4) and total EITC exposure is divided into different periods of childhood (columns 3 and 4) to allow for differences in the timing of additional exposure.

Results suggest that childhood exposure to the EITC does impact future business ownership. Columns 1 and 2 show that total EITC exposure is more important for future business ownership than increases in EITC exposure during specific points in childhood (columns 3 and 4). A $1,000 increase in total EITC exposure increases the likelihood of future business ownership at age 25 by 0.31 percentage points (or 2.8%). For business ownership by age 35, the effect of increased EITC exposure is similar: a $1,000 increase in total EITC exposure increases the likelihood of being a business owner by age 35 by 0.327 percentage points (or 2.5%). Columns 3 and 4 test for the effect of increases in EITC exposure by different points in the individual's childhood: ages 0-5, 6-12, and 13-18. I find that the timing of the increases in EITC exposure does not impact future business ownership. None of the coefficients on EITC by age group are statistically significant for either business ownership by age 25 or by age 35.

To ensure that these results are not being driven by children from higher income families that were not eligible for the EITC, I estimate the effect of total EITC exposure on business ownership by age 25 [2] for different maximum incomes. Since I am using the total potential childhood exposure from birth to age 18, I average the family income for each individual from birth to age 18 instead of using a the family income from a single year. Figure 2.3 shows that the effect of an additional $1,000 of EITC exposure is strongest for individuals from the most disadvantaged families. This suggests that the children from the lowest-income household benefit the most, in terms of owning a business in the future, from EITC expansions.

The effect of EITC exposure on business ownership is different for different subset of the full sample. Table 2.4 shows the results for various subgroups: males, females, black individuals, Hispanic individuals, children whose parent was an entrepreneur, children whose parent was a business owner, children with parents without a BA, and children of unmarried parents. Using the full set of controls, estimates show the effect of an addition $1,000 of total EITC exposure on the likelihood of owning a business by age 25 (panel A) and by age 35 (Panel B). Results indicate that the effect of additional EITC exposure during childhood is greater for females. A $1,000 increase in exposure increases the likelihood of being a business owner by age 25 by about 0.46 percentage points (or 5%) for females. The effect is similar for becoming a business owner by age 35 as well (0.4 percentage points).This effect is much larger than the effect for males despite having similar levels of exposure for both groups (about $35,800 and $ 36,200 respectively). Results are also larger for individuals with parents with the least amount of education where the least amount of education is defined as not having a bachelor's degree. Increasing EITC exposure by $1,000 for individuals with parents without a bachelor's degree are 0.31 percentage points (about 3%) more likely to be a business owner by age 25 and 0.34 percentage points (2.8%) more likely to own a business by age 35. This result shows that expansions in the EITC do positively impact future

[2]This exercise is repeated for business ownership by age 35 without any meaningful difference in the results. This figure can be found in the appendix

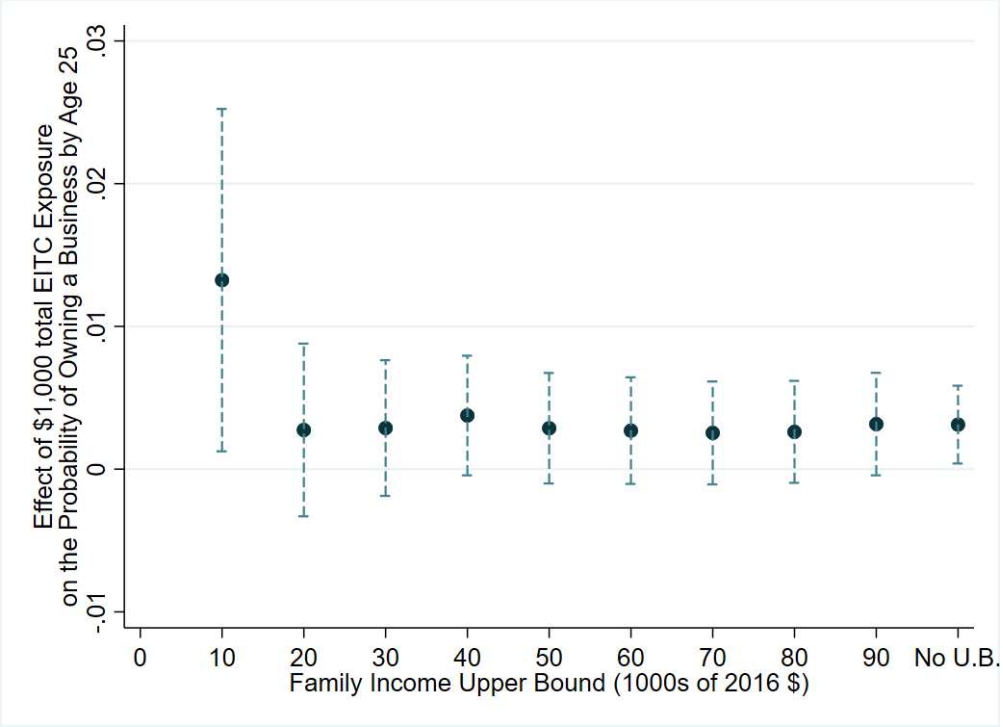


Figure 2.3: The Effect Earned Income Tax Credit (EITC) Exposure on Business Ownership by Income Threshold

Earned Income Tax Credit (EITC) exposure has the largest effect for individuals from low-income families. Each point represents the estimate of the effect of a $1,000 of EITC exposure on the likelihood of becoming a business owner by age 25 from a separate ordinary least squares regression. EITC exposure is shown in thousands of dollars and is defined as the maximum potential federal and state EITC a household could receive, given the year, state, and number of children in the household. Regressions include demographic controls; state-year controls at the age of business ownership; indicators for state of residence at time of business ownership, year of birth, and year of business ownership; and state-specific quadratic time trends. For individuals that did not become business owners, control variables are taken at the average age of business ownership. Vertical bars represent 95% confidence intervals. Standard errors are clustered at the state level.

business ownership by children from parents without college degrees, who are more likely to be affected by these expansions than those with at least a bachelor's degree.

2.5.2 Mechanisms

The results above suggest that increasing the amount of Earned Income Tax Credit to which a child is exposed to has a positive impact on their future business ownership. It does not appear to have a similar impact on future self-employment. I explore some mechanisms which may result in these differences and whether the demonstration effect or the resource effect is driving the above results. Table 2.5 tests directly whether there is an increase in business ownership from increased total exposure if the child's parents are entrepreneurs. I analyze the effect of the EITC for two new subgroups: children whose parents consider themselves entrepreneurs and child whose parents own a business. All regressions include a demographic, family, and state controls as well as indicator variables for state, year, cohort, and state time trends.

For the children whose parents consider themselves an entrepreneur, the results in table 2.5 show the EITC did not have a substantial impact. There is not a statistically significant effect of increasing childhood EITC exposure on owning a business by age 25 or by age 35. Similarly, the EITC does not have a substantial impact on owning a business for the sub-sample of individuals whose parents own a business. I again, find no statistically significant effects of increasing childhood EITC exposure on business ownership by both age 25 and by age 35.

These results imply that there is not much of a demonstration effect for owning a business as an adult. If there were a demonstration effect present, I would expect see a positive and significant increase in the likelihood of owning a business as an adult from an increase in EITC exposure for these sub-samples. Other evidence in favor of the demonstration effect would be that the estimated effect would be larger for these sub-groups. I however find smaller effects for both groups and a negative effect for the individuals whose parents are business owners, though no results are statistically significant. These results are contrary to what Lindquist, Sol, and Van Praag (2015) find.

They find that parental entrepreneurship increases the probability of the children's entrepreneurship. The difference in outcomes could stem from this paper's focus on the effects of the EITC on entrepreneurship whereas Lindquist, Sol, and Van Praag focus solely on the entrepreneurship of the parents and do not have an intermediary effect which influences the entrepreneurial decisions of the children.

Table 2.4: Business Ownership by sub population

	(1) Female	(2) Male	(3) Black	(4) Hispanic	(5) Least Educated Parents	(6) Single Parent
Panel A: ...by 25						
Total EITC Exposure ($000s)	0.00456**	-0.000298	0.00112	0.00428	0.00310*	0.00255
	(0.00182)	(0.00231)	(0.00282)	(0.00335)	(0.00154)	(0.00200)
Dep. var. mean	0.0859	0.139	0.109	0.0682	0.104	0.0887
Mean EITC exposure	35.8	36.2	34.9	35.6	35.0	34.6
Observations	978	925	497	396	1352	665
R^2	0.206	0.160	0.196	0.271	0.130	0.247
Panel B: ... by 35						
Total EITC Exposure ($000s)	0.00399**	0.000275	0.000955	0.00500	0.00338**	0.00233
	(0.00175)	(0.00204)	(0.00280)	(0.00335)	(0.00143)	(0.00195)
Dep. var. mean	0.100	0.161	0.119	0.0909	0.121	0.102
Mean EITC exposure	35.8	36.2	34.9	35.6	35.0	34.6
Observations	978	925	497	396	1352	665
R^2	0.321	0.294	0.294	0.463	0.267	0.361

EITC exposure is defined as the maximum potential federal and state EITC a household could receive, given the year, state, and number of children in the household. Results reflect the estimation of equation (1) and include demographic controls; state-year controls at the age of business ownership; indicators for state of residence at time of business ownership, year of birth, and year of business ownership; and state-specific quadratic time trends. For individuals that did not become business owners, control variables are taken at the average age of business ownership. Least educated parents is defined as the parent not having obtaing a bachelor's degree. Standard errors (in parentheses) are clustered at the state level. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$

I also investigate whether there is evidence of a resource effect. To test for a resource effect, I test whether increases in childhood EITC exposure affects the preferences for risk of the child. Becoming an entrepreneur is a risky endeavor because it requires the entrepreneur to shoulder most of the risk associated with a new start-up while forgoing the relative security of wage and salary work. Increases in EITC exposure as a child may affect the preference for risk which will affect the likelihood of future entrepreneurship. There is evidence that higher socioeconomic status individuals have a lower preference for risk (Falk et al. 2021), so increasing the family resources through the EITC may reduce the child's taste for risk. To test this empirically, I estimate:

$$Risk_i = \beta_0 + \beta_1 EITC_i + \gamma X_i + \pi Z_s + \eta W_t + \epsilon_i \tag{2.2}$$

Where $Risk_i$ is an indicator for whether the individual has a high preference for risk or a low preference for risk. There is a risk assessment included in the NLSYCYA, which is administered to each individual. It asks six different questions to assess the individual's attitudes towards risk and includes items such "I often get in a jam because I do things without thinking" and "I enjoy taking risks" [3]. For each item, the individual must state how much they agree or disagree with the statements on a four point scale. I then average each of these individual scores and then divide the averages in to higher preference for risk or lower preference for risk [4] and use this as my dependent variable. The coefficient of interest is β_1 and it represents the impact of a $1,000 increase in EITC exposure during childhood on the likelihood of having a higher preference for risk. I also divide EITC exposure into different developmental periods of childhood to test whether the timing of the exposure affects the individual's preference for risk.

[3] The full battery of questions can be found in the appendix

[4] I also perform an ordered probit and ordered logit specifications using the four point scale and achieve similar results. These results can be found in the appendix.

Table 2.5: The Effect of the Earned Income Tax Credit (EITC) on Business Ownership for Children with Entrepreneurial Parents

	(1) Parent Entrepreneur	(2) Parent Business Owner
Panel A: ...by 25		
Total EITC Exposure ($000s)	0.000829	-0.00359
	(0.0111)	(0.00744)
Dep. var. mean	0.137	0.147
Mean EITC exposure	37.17	36.90
Observations	233	252
R^2	0.447	0.494
Panel B: ... by 35		
Total EITC Exposure ($000s)	0.00174	-0.00359
	(0.0114)	(0.00744)
Dep. var. mean	0.155	0.171
Mean EITC exposure	37.17	36.90
Observations	233	252
R^2	0.506	0.552

EITC exposure is defined as the maximum potential federal and state EITC a household could receive, given the year, state, and number of children in the household. Results reflect the estimation of equation (1) and include demographic controls; state-year controls at the age of business ownership; indicators for state of residence at time of business ownership, year of birth, and year of business ownership; and state-specific quadratic time trends. For individuals that did not become business owners, control variables are taken at the average age of business ownership. Standard errors (in parentheses) are clustered at the state level. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$

Table 2.6: The Effect of the Earned Income Tax Credit (EITC) on Risk Preferences

	(1) High Risk	(2) High Risk
Total EITC Exposure ($000s)	-0.00573***	
	(0.00207)	
EITC Exposure Age 0-5 ($000s)		-0.0410
		(0.0439)
EITC Exposure Age 6-12 ($000s)		0.00325
		(0.0117)
EITC Exposure Age 13-18 ($000s)		-0.00817*
		(0.00409)
Observations	1903	1903
R^2	0.110	0.110

EITC exposure is defined as the maximum potential federal and state EITC a household could receive, given the year, state, and number of children in the household. Results reflect the estimation of equation (1) and include demographic controls; state-year controls at the age of the risk assessment; indicators for state of residence at time of the risk assessment, year of birth, and year of the risk assessment; and state-specific quadratic time trends. Standard errors (in parentheses) are clustered at the state level. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$

The term X_i represents a vector of personal and family characteristics which includes parental marital status, the number of siblings, if their parent considers themselves to be an entrepreneur, if their parent owns a business, as well as indicators for female, black, Hispanic and year of birth. Z_s and W_t are indicators for state of residence at the time of the assessment, and the year that the assessment was administered respectively. I also include state specific linear and quadratic time trends. Standard errors are again clustered at the state level to account for unobserved correlation of the error terms within states.

Table 2.6 presents the results from estimating the effect of childhood EITC exposure on whether the individual has a high taste for risk. Column 1 presents the results for total EITC exposure while column two divides total EITC exposure into exposure during three different age categories: 0-5, 6-12, and 13-18.

The results in table 2.6 suggest that increasing childhood exposure does impact the individual's preference for risk. Column 1 shows that increases in the total amount of exposure is important for determining the likelihood of having a greater tolerance for risk. A $1,000 increase in total EITC exposure reduces the likelihood of having more of a preference for risk by 0.573 percentage points. When compared to the mean, this translates to a 0.95% reduction relative to the mean. Column 2 shows that the timing of the EITC exposure does impact the preferences for risk. A $1,000 increase in EITC exposure during the ages of 13-18 has a greater impact than increases in exposure during other points of childhood. Increasing exposure during this time by $1,000 decreases the likelihood of hiving a higher risk tolerance by 0.817 percentage points (or 1.36%). This effect is even larger than the effect for and increase in total EITC exposure. Increased exposure during the ages 0-5 also decreases the preference for risk, while increases during the ages 6-12 actually increases it, but neither result is statistically significant at conventional levels.

These results are suggestive of there being a resource effect instead of a demonstration effect. Becoming an entrepreneur is riskier than working for another business. This is especially true of lower productivity endeavors which have a lower probability of expansion and security. Many self-employment endeavors fall into this category. These results combined with the previous results for self-employment suggest that one of the ways that childhood EITC exposure affects future entrepreneurship is by reducing the tolerance for risk. Greater family resources impacts the individual's preference for risk, which then reduces the probability of being self-employed in the future. I had previously found no significant impact of EITC exposure on self-employment which is consistent with this resource effect story. While the impacts are not statistically significant, the sign on the coefficient of interest is consistent with this hypothesis. Owning a business is less risky than being self-employed since the types of businesses that fall into the former category are more productive and stable. Is is also possible that the increased productivity also is able to compensate the individual enough to overcome the associated risk, which is why there is still a positive effect from the increased resources from the EITC on owning a business as an adult.

In all, these mechanisms point to the resource effect being the dominant effect. There is no evidence that increases in EITC affects the likelihood of owning a business for those individuals who have an entrepreneurial parent, and the likelihood of having an greater preference for risk decreases with increased EITC exposure. This suggests that it is the increased family resources during childhood from the EITC that increase the probability of the children becoming business owners as an adult.

2.6 Conclusion

This paper analyzed the long-term impact of childhood Earned Income Tax Credit exposure on entrepreneurial outcomes for individuals born between 1984 and 1991. Using variation in state and federal EITC benefits by family size over the duration of childhood, results indicate that the EITC significantly increases the likelihood of owning a business as an adult. Increasing the total amount of EITC available to the family by $1,000, increases the likelihood of becoming a business owner by age 25 by 2.8% and becoming a business owner by age 35 by 2.5%. I do not find any significant increases in the likelihood of being self-employed.

I find little evidence that the timing of the increases in the EITC affects adult entrepreneurship. This suggests that the total amount of additional resources available to the child is more important than the timing of the delivery of the resources. While this is different than the existing literature focusing on the other long-term impacts of the EITC, it could be due to the smaller range of birth cohorts used for this study due to the necessary linkages between parents and children. Also, entrepreneurship is an activity that often occurs at older ages, so I measure my outcome variables later in adulthood (25 and 35). It is possible that the youngest individuals in my sample have not fully realized their entrepreneurial outcomes yet. More time may be needed before the effects of the EITC on future entrepreneurship are able to be fully identified.

When examining the mechanisms through which the EITC may be impacting future business ownership, I first test whether there is a demonstration effect. Since the work requirement for EITC

eligibility can be satisfied through self-employment, parents who do so may provide an example of entrepreneurship for their children. However, I find that there little evidence of a demonstration effect. Increasing the EITC exposure during childhood for the children of entrepreneurial parents does not increase the likelihood that the children become business owners as adults. I then test if increasing childhood exposure to the EITC affects the child's preferences for risk because becoming an entrepreneur is relatively riskier than being an employee. Increasing total EITC exposure by $1,000 reduces the likelihood of having a greater risk tolerance by 0.95% and increases in exposure during the ages 13-18 reduce the likelihood even more (1.36%). These results help explain why there is not an increase in the likelihood of self-employment as an adult with increase EITC exposure as a child. The children of EITC recipients do not become self-employed because self-employment is riskier and increases in family resources reduces their taste for risk. This does not appear to impact future business ownership however, which may be because the rewards from business ownership are enough to compensate for the associated risk. These results suggest that the additional resources provided by increases in the EITC are the dominating effect for why there is an observed increase in adult business ownership.

This paper has shown that, in addition to lifting millions of households out of poverty each year, the EITC also improves the long-term outcomes of the children of EITC recipients. The EITC is one of the largest tools available to fight poverty, that distributed an average of $2,411 dollars to over 25 million individuals in 2021 (*EITC Fast Facts* 2020). This paper has shown that in addition to these effects, the EITC helps the children of recipients become business owners as an adult while reducing the likelihood of lower productivity self-employment. This provides further evidence that the EITC helps the current generation as well as improving outcomes for future generations and impacting the broader economy.

Chapter 2 References

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Chapter 3

The Impact of New World Crops on the Indian Economy

3.1 Introduction

Following the exploration of Christopher Columbus, trade opened between the New and the Old Worlds. This “Columbian Exchange" facilitated the movement of both people and crops across the Atlantic Ocean. Much of the focus on this exchange has focused on Europe and the Americas, but these newly opened trade routes had effects elsewhere as well. One of the important effects of the Columbian Exchange was the introduction of new crops. Often the crops from the New World were more nutritious and more productive than their counterparts from the Old World and soon became staples in the diets of the Old World.

Around this same time world population grew rapidly. There were under 300 million people globally in 1000 CE. By 1900 population had grown to 1.6 billion (Nunn and Qian 2011). Some have attributed a portion of this rapid growth in population to the introduction of these New World Crops (eg. Langer (1963) and McNeill (1949)). The evidence for this has been borne out by empirical research as well (Nunn and Qian 2011; Chen and Kung 2016; Cherniwchan and Moreno-Cruz 2019). Whether or not the new crops contributed to economic growth is still unclear.

In this paper, I test whether the introduction of a New World crop, maize, to India is sufficient to spur economic growth as well as population growth. The introduction of the New World crops create an agricultural productivity shock since they were more productive and nutritious than the existing crops. I focus on maize in this paper because of its suitability to become a staple crop as well as the timing of its introduction. The effect on population follows from a straightforward Malthusian process: the greater yield and calories means that a greater population can be supported

with the same amount of cultivated land. The effect on economic growth is not as direct. If the New World crops are productive enough, then sufficient food can be produced with fewer resources, including both land and labor. This frees some labor to work in more productive sectors spurring economic growth. Other studies have examined these and similar questions for other geographies, but the evidence for the sufficiency of a New World crop increasing economic growth has been mixed.

To estimate the impacts of maize on the Indian economy I exploit variation in the suitability of growing conditions for maize in India. Since India is a large country with varying geography and climates, there exist differences in the suitability of the crop land for maize. Using the timing of introduction of maize to India I test if greater suitability increases population density and economic growth, as measured by urbanization. If the maize does increase both population and economic growth it is more likely to do so in the regions where the growing conditions for maize are more favorable.

Using these sources of variation, I estimate two different specifications. The first specification is a panel difference-in-differences specification. This compares outcomes from states with more suitable conditions for growing maize to the outcomes of states with less suitable conditions for growing maize, before and after maize was introduced to the sub-continent. This specification controls for time-invariant state characteristics, as well as country wide trends. The second specification builds upon the first by including spatial lags of the dependent variable as additional regressors. This model allows for me to control for spatial dependencies between states such as agglomeration and population spillovers that may otherwise confound the growth effects of the introduction of maize. I use a panel of data on Indian states from 1400 to 1800 which contain information on population and urbanization levels, the suitability of maize as a crop, and other state characteristics.

Using the simple difference-in-differences specification, I find that the introduction of maize does significantly increase urbanization of states in India. Using the preferred set of estimates which controls for differential trends in contact with Europeans and climate, I find that a 1% increases in the suitability index for growing maize increases urbanization by 0.00446%. This implies that the introduction of maize was responsible for about 8% of the growth in urbanization during the sample period. This specification, however, does not find any significant impacts from the introduction of maize on population density. When accounting for the spatial spillovers for growth, I find more evidence that the introduction of maize does positively impact the Indian economy. A 1% increase in the suitability for growing maize increases population density by 0.0244% and urbanization by 0.0036%. These results imply that the introduction of maize significantly impacted the pre-colonial Indian economy. The introduction of maize accounted for about 8% of population growth and about 8% of the growth in urbanization.

This work contributes to a growing strain of literature examining the effects of New World crops that were introduced via the Columbian Exchange. The introduction of the potato to Europe has been shown to contribute to both increased population density and economic growth (Nunn and Qian 2011). Cook (2014) builds on the work of Nunn and Qian (2011), and shows that areas with more milk consumption with potatoes is what increases density and economic growth opposed to just potatoes. The adoption of clover in Denmark also contributed to its growth, both in population and economic growth (Dall Schmidt, Jensen, and Naz 2018). The effects of a new crop on economic growth are not universal; other studies have found that the introduction of New World crops only contribute to increased population density. Chen and Kung (2016) and Cherniwchan and Moreno-Cruz (2019) find this for China and Africa, respectively. By focusing on India, I will be providing further evidence whether the introduction of a New World Crop is sufficient to increase both population and economic growth.

This paper also helps explain the differences in growth between Europe and Asia before 1800 know as the Great Divergence. Before 1800, historians claim that Europe and Asia were similarly

developed because the grain wages were similar (Broadberry and Gupta 2006). Broadberry and Gupta (2006) show that the divergence began earlier. This difference in responses to the introduction of a New World crop in Europe and China may help explain why the two regions' fortunes diverged. Voigtländer and Voth (2013) claim that another reason for the Great Divergence is due to the plague and the nearly constant wars. The plague reduced population which applied upward pressure on real wages, and the lack of unified political structure led to wars which also led to increased wages. The wages stayed high even as population grew. The introduction of a New World crop may have also contributed to these trends.

I also contribute to the literature on the determinants of urbanization. How a location transitions from rural to urban depends of the suitability of the land for crop cultivation, seasonal frosts, access to waterways, and lower elevations (Motamed, Florax, and Masters 2014). The same study then looks at the equivalent modern countries and finds that earlier urbanization is associated with higher per capita incomes. The geographic features of a location are also important determinants of urbanization. Bosker and Buringh (2017) find that "first nature" characteristics such as natural resources, agricultural potential, transportation potential, and defensive advantages, are important seeds for city growth. They also find that proximity to other urban centers, or "second nature geography" is also an important determinant of urbanization; a location may have excellent first center geography but without sufficient second nature geography characteristics those locations do not become urban centers (Bosker and Buringh 2017). Many present day urban areas are located where fall line portages existed (Bleakley and Lin 2012; Bleakley and Lin 2015) despite portages being no longer necessary. This shows that where urban centers first develop continue to be urbanized areas in modern times, so focusing on whether maize suitability contributes to historical urbanization can help explain present urbanization.

The remainder of the paper proceeds as follows. Section 3.2 provides the historical setting around the time of the introduction of maize. Section 3.3 discusses the choice of maize. Section

3.4 outlines the data and methodology used for analysis. Section 3.5 presents the results, and Section 3.6 concludes.

3.2 History of the Indian Economy

The Pre-Colonial Indian economy was defined by small-scale farmers. Land and labor were abundant, but land was not bought and sold as a commodity during this period (Rothermund 1988). However, the number of people available to work the land was greater than quantity of suitable crop land. This led to a feudal-like system where landlords taxed the output of the peasant farmers who tilled the land, keeping some for themselves and paying patronage to the local lord with the rest (Rothermund 1988). This system of extraction remained decentralized because of the lack of monetization which increased the cost of transportation.

This system remained unchanged until the beginning of the Mughal Empire in the 1500s near Delhi. The Mughals were a warring state and were preoccupied with attacking their neighbors and expanding their empire (Richards 2003). Their efforts were largely successful because they had the superior military technology of horses (Rothermund 1988) which allowed them to overpower the local lords. By 1690, the Mughals had expanded their empire to cover most of the subcontinent and had approximately 100 million people living in those lands (Richards 2003).

The Mughals brought centralization and standardization to the local tax system, facilitating the movement of people, money, goods, and information. The emperor would place trusted officers in local villages to oversee the collection of the land tax (Richards 2003). This led to new urban centers in the countryside to be established and act as trading and tax collection hubs (Rothermund 1988). Along with centralization, came increased costs of maintaining the empire-wide tax collection system. This required increased taxes and caused an increase in the amount of land that was cultivated to produce more crops, so the peasants working the land could afford the taxes levied on them (Richards 2003).

Markets remained fragmented, however. Only lightweight, expensive goods were transported long distances due to the lack of adequate roads and reliance on pack animals. All other goods were traded locally (Rothermund 1988). This meant that taxes needed to be paid in silver imperial coin (Richards 2003). Silver was not produced within the empire, so it needed to be imported from abroad. This led to increased trade with Europeans who had a high demand for Indian goods (Rothermund 1988). Though there was a large population, its absorptive capacity was not great enough to prevent inflation from increasing (Rothermund 1988). Inflationary pressures meant that peasants needed to cultivate more land and produce more agricultural crops to be able to afford the land tax to which they were still subjected (Rothermund 1988; Richards 2003). Eventually, the system fell apart as taxes rose. Peasants could not benefit from higher prices because of the lack of integrated markets, so they were subject to only local prices which were not high enough to afford the high taxes and maintain their subsistence (Rothermund 1988). The Mughal Empire eventually ended in the mid-1800s.

The introduction of New World crops may have been an important innovation given this backdrop. If the new crops were more productive, the required amount of grain could be produced with fewer inputs, making the payment of taxes easier for the peasants. This history outlines other factors such as the expansion of the Mughal Empire and trade with Europeans that must be accounted for in the empirical analysis.

3.3 Suitability of Maize

For a New World crop to possibly be the reason for increased population density and urbanization it needs to be widely adopted and more nutritious than the existing crops. Maize was not the only crop to make it to India, but it is the most likely to have become a dietary staple.

Nunn and Qian (2010) highlight that capsicum peppers from the New World were first introduced to India around 1542. While capsicum peppers are high in vitamin A, B, and C, these peppers are not eaten in large enough quantities for them to cause an agricultural productivity shock.

This is helpful for understanding the timing of when a potential new staple crop was introduced, however.

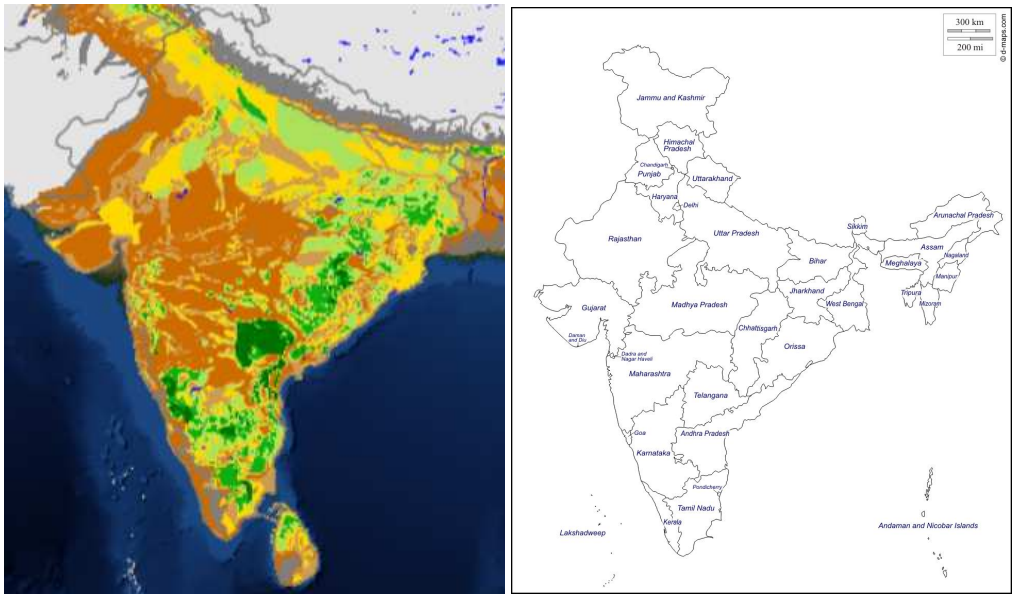
One potential crop highlighted by the previous research was the white potato. This crop was first introduced to India by Europeans, and the first recorded mention of the potato is from 1615 (Mazumdar 1999). While the timing of this crop is right, the potato was generally a supplement to the Indian diet,and thus, spread slowly not gaining widespread adoption until the late 18th century (Nunn and Qian 2011). Maize, on the other hand, did have widespread adoption in precolonial India and became a dietary staple (Mazumdar 1999). Given the other evidence for when New World crops were first introduced to India, one can assume that maize was introduced around the same time.

Table 3.1: Annual Crop Yields of Various Staple Crops

Crop	Yield (kg/ha)	Energy (MJ/ha)
Millet-Sorghum	1200	17,800
Maize	1700	26,000
Cassava	4000	26,8000
Sweet Potatoes	8000	28,800
White Potatoes	4400	14,200

Source: Cherniwchan and Moreno-Cruz (2019)

For there to be an agricultural productivity shock the new crop must be more nutritious per area of land than the existing crops. Prior to the adoption of the New World crops, Indians subsisted on millet and sorghum (Mazumdar 1999). The table from Cherniwchan and Moreno-Cruz (2019) shows the yield of several New World crops per hectare as well as the nutritional value per hectare, compared to millet and sorghum. All of the New World crops are much more nutritious per hectare than either millet and sorghum. This combined with the timing of introduction and adoption of the crops suggests that maize is the most likely candidate to have caused an agricultural productivity shock in India.



Source: FAO-GAEZ Source: https://maps-india-in.com

Figure 3.1: Suitability of Maize and Indian States

3.4 Data and Methodology

3.4.1 Identification

I use the suitability index for maize since I do not have historical maize production data. As shown in Figure **??**, there is significant variation in the suitability of growing conditions for maize. The figure divides suitability into eight possible categories, from "Very High", in dark green, to "Not Suitable" in light grey. These categories reflect differences in the potential capacity of land to produce maize at the maximum yield due to differences in geographical, soil and climatic conditions. These differences create variation which can used to identify the effects of maize; average outcomes can be compared from places where it is highly suitable (such as parts Telangana) with average outcomes from locations where it is not (such as Gujarat and Madhya Pradesh).

The second source of variation comes from changes in the availability of maize over time. As previously discussed, I am not able to observe the exact time of introduction of maize for every state. Maize was first introduced around the same time as potatoes in 1615, after which it spread quickly throughout the country. Since I am not able to observe the introduction of maize for each

individual state I treat the introduction as a common shock to all states. I exploit this temporal variation by comparing average outcomes before and after maize was introduced to India.

I identify the effects of the introduction of maize on both population density and economic growth by exploiting these two sources of variation using difference in differences. Since I am not able to observe economic growth directly I proxy for economic growth with urbanization. This approach compares the average population densities of, or the average urbanization of states where land was suitable for adopting maize with the same outcomes for states where adoption was not possible due to lack of suitable land. This allows me to control for a number of time-invariant factors, such as a state's geographic characteristics and advantages, and trends common to all states, such as ongoing technological change that would otherwise confound identification.

This idea rests on the fact that maize was only suitable as a crop in a subset of states. This means that, while it was potentially available everywhere in India after its introduction, maize could only be adopted in places where it could be grown due to exogenous factors. While all states may have tried to adopt maize once it was introduced due to factors such as existing population pressures, adoption was not possible everywhere due to geography. Since the ability of the land to grow maize was not known prior to introduction, this rules out the possibility that my estimates are capturing existing effects rather than the effect of maize.

3.4.2 Data

This research design requires cross-state data on the suitability of maize. I follow an approach similar to Nunn and Qian (2011) and Cherniwchan and Moreno-Cruz (2019) and use a measure of suitability from the FAO-GAEZ data. I use the average land suitability index for growing maize by state under low-input productivity and rain irrigation conditions. The conditions best reflect the agricultural technology available in India during the periods of interest.

Table 3.2: Summary Statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Maize Suitability	198	31.52	17.61	1	57
Population Density	198	50.89	64.48	0.577	415.5
Urbanization	198	0.0634	0.0476	0	0.337

This research also requires data on population density and urbanization before and after the introduction of maize. I create these variables from the data contained in the History Database of the Global Environment version 3.1 . These data contain information on land use for the past 12,000 years including estimates for total population and population living in urban areas. These data are available at the five minute grid-cell. I aggregate these data up to the Indian state level for each state. For the grid-cells that intersect borders, I weight the estimates by the proportion of the grid-cell in each state. To obtain population density, I divide the aggregated population by the total land area of each state. Urbanization is calculated by taking the aggregated urban population and dividing by the total population.

Combining these data sources yields the two main panels of data utilized in the analysis: one for maize suitability and population density and one for maize suitability and urbanization. I focus the period of analysis to the time period immediately surrounding the introduction of maize: 1400-1800. The data is available by century from 1400-1700 and then by half century thereafter.

3.4.3 Empirical Specification

I implement the above research design by estimating the following specification:

$$Y_{it} = \beta_0 + \beta_1[Maize_i \times post_t] + X_{it}\Gamma + \eta_i + \lambda_t + \epsilon_{it}$$

where Y_{it} is either the natural log of population density or the natural log of 1 plus urbanization in state i at period t. Each state's treatment is captured by $Maize_i \times post_t$, which is the natural

log of maize suitability multiplied by a post-introduction indicator variable. The post-introduction indicator is equal to 1 if the time period is later than 1615 and 0 otherwise because the available evidence suggests that maize was adopted widely in India around this time. X_{it} are additional controls that capture other factors that may have impacted the adoption of maize such as contact with Europeans, climate conditions, and expansion of the Mughal Empire. η_i are the state fixed effects designed to capture the unobserved, time-invariant factors that may affect population density and urbanization, and λ_t are the period specific fixed effects that capture aggregate shocks that are common to all states. μ_{it} is an error term that captures idiosyncratic changes in either population density, or urbanization.

The coefficient of interest is β, which captures the effect of the introduction of maize on each outcome. When examining population density $\hat{\beta}_1$ should be positive. This is consistent with Malthus's theory on population: new technology will increase output and the increased output will lead to greater population growth. When urbanization is the outcome of interest, if the introduction of maize is sufficient to induce economic growth, $\hat{\beta}$ should also be positive since urbanization is closely related to economic growth. If it is not sufficient, then I would expect $\hat{\beta}_1$ to not be statistically significant.

The effects of the introduction of maize may not be isolated within a state's borders. The economic growth of one state may impact the growth of states nearby. Patterns of trade and regional agglomeration are two possible factors that may impact the adoption of maize and economic growth in states. To account for these spatial spillovers, I also implement a spatial lag model as a second specification:

$$Y_{it} = \beta_0 + \beta_1[Maize_i \times post_t] + X_{it}\Gamma + W\ Y_{-it} + \eta_i + \lambda_t + \epsilon_{it}$$

This specification is the same as above with the addition of $W\ \ Y{-}it$. This is the dependent variable of all other states $(-i)$ weighted by a spatial weighting matrix W. I implement a contiguity

weighting matrix such that the each of a states neighbor with which it shares a border receive a weight of 1, and all other states with which it does not share a border receive a weight of 0. This weighting scheme is used instead of others because of the great size of the Indian sub-continent and many of the states are also geographically large. Therefore, it is more likely that a state's immediate neighbors have a greater influence on its own growth than another state that is much farther away.

3.5 Results

3.5.1 Baseline Results

Table 3.3 presents the results from estimating the effect of the introduction of maize on economic growth in precolonial India. Each panel of the table presents a different aspect of economic growth: Panel A presents the results for population density, and Panel B presents the results for urbanization. The first specification, in column 1 of each panel, includes no controls other than period and state fixed effects. This specification controls for time-invariant cross-state differences such as geography, and country-wide trends, such as technological change that may have affected the introduction and adoption of maize. The second specification in column 2, adds the natural log of the distance from the center of the state to India's border or coast, whichever is closer, interacted with the period fixed effects to account for differential trends in potential contact with Europeans. Column 3 adds the natural log of distance from the equator and elevation, two key factors in determining climate, interacted with period fixed effects to account for differential climate trends across states. Standard errors are clustered at the state level.

Panel A of Table 3.3 reports the estimates of the effects of the introduction of maize on population density. Column 1 indicates that a 1 percent increase in the a state's suitability conditions for growing maize increases population density by 0.0296 percent. This result is in line with the estimate of the introduction of maize in Africa found by Cherniwchan and Moreno-Cruz (2019). These results are sensitive to including controls, however. Column 2 adds a control for potential

Table 3.3: The Effect of the Introduction of Maize on Economic Growth

	(1)	(2)	(3)
Panel A: Population Density			
ln(Maize)xPost	0.0296*	0.0360**	0.0131
	(0.0152)	(0.0165)	(0.0161)
EuropeanContact		X	X
Climate			X
adjustedR2	0.970	0.971	0.980
Panel B: Urbanization			
ln(Maize)xPost	-0.00101	-0.000868	0.00446***
	(0.00116)	(0.00167)	(0.00157)
EuropeanContact		X	X
Climate			X
adjustedR2	0.192	0.258	0.552

Table reports the estimates of the effect of maize on population density and urbanization. Panel A reports the results from the regression of the natural log of population density (people/km^2) regressed on the natural log of maize suitability interacted with an indicator for post maize introduction and other controls. Panel B reports the results from the regression of the natural log of urbanization (urban population/total population) regressed on the natural log of maize suitability interacted with an indicator for post maize introduction and other controls. All control variable are interacted with the full set of period fixed effects. The post maize introduction variable takes the value of 1 for any period after 1615. All regressions include state and period fixed effects. Standard are clustered at the state level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$

European contact and the effect of the introduction of maize on population density increases 0.0360 percent, and column 3 adds controls for climate which reduces the estimate to 0.0131 percent and it is no longer statistically significant.

Panel B of Table 3.3 presents the estimates of the the effect of the introduction of maize on urbanization. The estimates for these specifications are also sensitive to the inclusion of controls. I find a negative, albeit insignificant, effect of the introduction of maize on urbanization in both columns 1 and 2. Once I include all of the controls for European contact and climate, I do find a positive and significant effect on urbanization from the introduction of maize. Increasing the suitability for growing maize by 1 percent increases the amount of urbanization in a state by 0.00446 percent. Given how sensitive both sets of specifications are to the inclusion of controls, the specifications in column 3 are my preferred set of estimates.

The estimates reported in Panel B of Table 3.3 provide some support for the introduction of maize impacting urbanization in India. However, from this estimate it is unclear how economically significant this result it. To better understand how meaningful this estimate is, I determine how much of the growth of urbanization can be attributed to maize for the average Indian state. I obtain the amount of urbanization attributable to maize by multiplying the estimate from column 3 of Panel B (0.00446) by the mean level of the measure for maize suitability (3.15). This calculation indicates that maize increased the level of urbanization in the average state by about 1.4 percent. Based on the data, the average state had share of total population living in urban areas of 0.07 in 1600, before maize was introduced, and the urban share was 0.06 in 1800 at the end of the sample period. This suggests that the urban share of the population grew by over 16%. Therefore around 8% of the total growth in the share of the urban population is due to maize. Altogether, the results in Table 3.3 show that maize did impact urbanization but not population density. This is suggestive that the introduction of maize allowed for some of the agricultural population to move to urban areas.

3.5.2 Alternative Explanations

The previous results show that the introduction of maize did not affect population density, but it did significantly impact urbanization. These baseline results may be capturing the effect of other factors. I first test whether these estimates are capturing the effect of other crops that may are important for the Indian diet. Second, I test whether the baseline estimates are capturing the effect of the expansion of the Mughal Empire, as its expansion may also determine population density and urbanization.

To test whether the baseline estimates are capturing the effect of other staple crops, I create similar measures as the $ln(Maize) \times Post$ for the white potato and for rice. The white potato is also a New World crop that was introduced around the same time as maize. I construct a measure the same way for the white potato as I do for maize, by taking the natural log of the state average growing suitability conditions for the white potato and interacting it with an indicator for periods later than 1650. The measure for rice is constructed slightly differently because rice was first cultivated in India much earlier than the sample period and is a staple crop in the Indian diet. For both of these reasons, I interact the natural log of the state average rice suitability conditions with the natural log of maize suitability and with the indicator for the introduction of maize. This construction treats maize as a supplemental crop, which may fit with the long history of rice in India.

The results of the alternative crop measures are presented in Table 3.4. For easy comparison, the first column re-presents the baseline results from column 3 in Table 3.3. Column 2 captures the introduction of the white potato alone, allowing for the possibility of the white potato being a staple crop. Column 3 includes both the measures for the introduction of maize and the introduction white potatoes, allowing for the possibility of the white potato being a supplemental crop. Column 4 includes the maize and rice measure with the introduction of maize, and column 5 includes both of alternative crop measures with the introduction of maize measure. Each specification includes

state and period fixed effects as well as the controls for European contact and climate. Standard errors are clustered at the state level.

Column 2 tests whether the introduction white potato alone instead of maize is what is driving the baseline results. I find similar effects for the white potato as I did for maize, but the effects are weaker overall. A one percent increase in white potato growing suitability increases urbanization by 0.00315 percent, but this estimate is only marginally significant. There is no apparent effect of increasing the growing suitability of the white potato on population density. It is possible that areas that are more suitable for maize are also more suitable for white potatoes, and given that they are introduced around the same time, these results may just be picking up on the introduction of maize. There is also historical evidence that at this time the white potato was not a staple crop and did not have widespread adoption (Nunn and Qian 2011) like maize, but a supplemental crop (Mazumdar 1999). Column 3 explores this hypothesis by including the introduction of the white potato along with the introduction of maize. This specification shows that it is the introduction of maize and not the white potato that is responsible for the baseline results. Increasing maize suitability does not have an effect on population density but it does affect urbanization controlling for the introduction of the white potato. A 1 percent increase in maize suitability increases urbanization by 0.00377 percent, though this result is also only significant at the 10% level.

Next I examine whether maize is a supplemental crop for rice and if areas that have better growing conditions for rice and maize experience more economic growth after the introduction of maize. Column 4 includes the maize and rice measure along with the measure for the introduction of maize. When testing this hypothesis, I do not find any effects for the effect of maize on population density, or on urbanization. Areas that have both good growing conditions for maize and for rice also do not experience greater population density or urbanization. States with better suitability for both crops actually see declines in population density. Even though this effect is not significant, combined with the other results, it is suggestive that maize did not function as a supplemental crop.

Table 3.4: The Effects of Other Crops on Economic Growth

	(1)	(2)	(3)	(4)	(5)
Panel A: Population Density					
ln(Maize)xPost	0.0131		0.0194	0.0306	0.0262
	(0.0161)		(0.0211)	(0.0632)	(0.0658)
ln(Potato)xPost		0.00487	-0.00726		-0.00563
		(0.0120)	(0.0158)		(0.0193)
ln(Maize)xln(Rice)xPost				-0.00457	-0.00216
				(0.0150)	(0.0181)
Adjusted R^2	0.978	0.977	0.977	0.977	0.977
AIC	-482.2	-480.7	-480.5	-480.4	-478.6
Panel B: Urbanization					
ln(Maize)xPost	0.00446***		0.00377*	0.000620	0.000659
	(0.00157)		(0.00218)	(0.00642)	(0.00636)
ln(Potato)xPost		0.00315*	0.000792		0.0000506
		(0.00178)	(0.00239)		(0.00253)
ln(Maize)xln(Rice)xPost				0.00100	0.000983
				(0.00181)	(0.00193)
Adjusted R^2	0.500	0.492	0.497	0.498	0.495
AIC	-1096.2	-1093.5	-1094.4	-1094.7	-1092.7

Table reports the estimates of the effect of maize on population density and urbanization. Panel A reports the results from the regression of the natural log of population density (people/km^2) regressed on the natural log of maize suitability interacted with an indicator for post maize introduction and other controls. Panel B reports the results from the regression of the natural log of urbanization (urban population/total population) regressed on the natural log of maize suitability interacted with an indicator for post maize introduction and other controls. All columns include controls for European contact and climate. The post maize introduction variable and the post potato introduction variable takes the value of 1 for any period after 1615. All regressions include state and period fixed effects. Standard are clustered at the state level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$

In column 5, I include each of the different crop measures to control for the effects of these other crops. I again do not find any significant effects on the introduction of maize or the other crops for population density or urbanization. The inclusion of these additional controls do not appear to improve the econometric model above the preferred specification from column 3 of the baseline results. Including the other crops along with maize reduces the adjusted R^2, suggesting that the additional variables do not improve the models' ability to explain the variation in population density or urbanization. The Akaike information criterion tells a similar story. Compared to the other models the Akaike information criterion points to the baseline model as the best specification for both of these outcomes. This suggests that the introduction of maize does increase urbanization.

Another alternative explanation for the increase in urbanization in the spread of the Mughal Empire. The Mughal Empire began in 1530 and continued through 1858 when the British Raj began, and at its peak consisted of most of the Indian sub-continent. The empire was a centralizing state and with each expansion, the empire sought to collect more resources through a land tax (Richards 2003). This tax brought more lands into cultivation and increased the production of rice throughout the subcontinent (Richards 2003). It is through the expansion of the empire and the increased cultivation of rice that the empire may directly affect population density and urbanization. To account for this, I map the territories of the Mughal Empire onto modern-day Indian states by period, and include an indicator variable for whether the state was part of the empire during that period. I also interact this indicator variable with the state average suitability for growing rice to account for in increases in rice production that occurred after the expansion of the Empire.

Table 3.5 presents the results for including the Mughal Empire indicator and its interaction with state average rice suitability. The outcome in column 1 is the natural log of population density and it is the natural log of urbanization in column 2. The results from these specification follow a similar pattern to the preferred baseline estimates for the introduction of maize. The introduction of maize does not appear to affect population density, but it does appear to increase urbanization. Increasing the average suitability of growing conditions for maize by 1 percent, increases

Table 3.5: The Effect of the Expansion of the Mughal Empire

	(1) log Population Density	(2) log Urbanization
ln(Maize)xPost	0.0161	0.00370**
	(0.0144)	(0.00157)
Mughal	0.135**	-0.00817*
	(0.0528)	(0.00441)
Mughal × ln(Rice)	-0.0340**	0.00225
	(0.0162)	(0.00145)
Observations	198	198
Adjusted R^2	0.979	0.489

Table reports the estimates of the effect of maize on population density and urbanization. Column 1 reports the results from the regression of the natural log of population density (people/km^2) regressed on the natural log of maize suitability interacted with an indicator for post maize introduction and other controls. Column 2 reports the results from the regression of the natural log of urbanization (urban population/total population) regressed on the natural log of maize suitability interacted with an indicator for post maize introduction and other controls. All columns include controls for European contact and climate. The post maize introduction variable and the post potato introduction variable takes the value of 1 for any period after 1615. All regressions include state and period fixed effects. Standard are clustered at the state level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$

urbanization by 0.0037 percent. The estimate is lower than the baseline results, but still of a similar magnitude. This means that when controlling for the effects of the expansion of the Mughal Empire, the introduction of maize accounts for 7.5% of the growth in urbanization.

The results in Table 3.5 also shows that the expansion of the Mughal Empire did have an impact on both population density and urbanization. For population density, the expansion of the empire had a direct impact as well as an indirect impact through its increased cultivation of rice. After the Mughal Empire expanded into a state, population density grew by 13.5 percent on average. This affect is more pronounced in areas that are not as suitable for growing rice. Increasing the suitability for growing rice in states that were part of the Mughal Empire by 1 percent decreases population density by 0.034 percent on average. One possible explanation for the decreased effect of empire expansion on state with better rice growing conditions is that since the land was more productive in those states, it took less labor to produce the same amount of rice, thereby reducing the population density of those states relative to less productive states.

The expansion of the Mughal Empire also affects the amount of urbanization in a state. Though, the effect of the expansion of the empire is different on urbanization than for population density. After the Mughals expand their empire into a state, urbanization decreases by 8.17 percent on average. Even though the population is increasing after the expansion of the empire, it is not adding more people to urban areas, which is again consistent with the increase in new lands being cultivated in order to pay the land tax extracted by the empire. There is suggestive evidence that in states that were better suited for growing rice urbanization increased, which is consistent with the possible explanation for the negative effect of increased rice suitability in Mughal states for population density, but the result is not statistically significant.

3.5.3 Spatial Spillovers

After testing alternative explanations, the introduction of maize appears to not have an effect on population density, but it does increase urbanization on average. However, regions do not grow uniformly. Trade patterns and forces of agglomeration can cause some regions to grow while others do not share in the same prosperity. Trade patterns may increase the populations of neighboring regions as more people move to areas of high trade for better market access. This may also affect urbanization. Agglomeration may negatively affect the urbanization of a neighbor as one area becomes a central hub and the outlying areas exist on the periphery to supplement the primary center. Both of these forces may arise because of the expansion of the Mughal Empire and its effects on population and urbanization. To account for these spillovers, I estimate a spatial panel model with spatial lags of the dependent variable.

By including a spatial lag of the dependent variable, I am able to account for these inter-state spillovers. The dependent variable for each state is included as a regressor and is weighted based on its relationship to all other states. For these spatial models, I use a contiguity weighting matrix. This means that for an individual state, the dependent variable of the neighbors for which it shares a border are given a weight of 1 and all other states with which it does not share a border receive a weight of 0. A contiguity weighting matrix make sense in this context because the Indian sub-

continent is large and many of the states are also geographically large, so it is more likely that a state's neighbors have a greater influence on its development than a state that is geographically distant.

It is possible that there may be spatial correlation of the idiosyncratic errors as well. Following the procedure in Beenstock and Felsenstein (2019), I perform the Moran test for spatial dependence of the errors and for both outcome. In each case I fail to reject the null hypothesis that the errors are i.i.d. (population density $\chi_1^2 = 0.97$ and urbanization $\chi_1^2 = 0.07$). Based on the results of this test I focus on the spatial lag of the dependent variable in stead of spatial error models or the spatial Durbin model.

Table 3.6 presents the results from these spatial models. I use two different specifications: one that is analogous to the baseline specification with controls for European contact and climate (column 1) and one that is analogous to the specification with controls with the Mughal Empire (column 2). Panel A and Panel B present the results for population density and urbanization, respectively.

When accounting for spatial spillovers from neighboring states, the introduction of maize does have a positive and statistically significant effect on population density. These effects cannot be interpreted directly, however. If the introduction of maize increases population density in state A, then that increase in state A spills over to further to other states, then that effect will spillover again onto state A, and so on. Instead the average effects from this recursive process must be examined. These effects are presented in Table 3.7. The total impact of a variable is comprised of its direct impact and its indirect impact. The direct impact is the effect of of a change within the state without accounting for spatial spillovers. The indirect impact is the spillover effect.

Table 3.6: Spatial Spillovers and the Effect of Maize on Economic Growth

	(1)	(2)
Panel A: Population Density		
ln(Maize)xPost	0.0266***	0.0261**
	(0.00987)	(0.0112)
Mughal		0.115**
		(0.0482)
Mughal × ln(Rice)		-0.0260
		(0.0171)
Wc		
log Population Density	-0.0971***	-0.0932***
	(0.0301)	(0.0296)
Observations	198	198
Wald Test of Spatial Terms	10.43	9.941
Panel B: Urbanization		
ln(Maize)xPost	0.00424***	0.00397**
	(0.00146)	(0.00178)
Mughal		-0.00898
		(0.00791)
Mughal × ln(Rice)		0.00240
		(0.00278)
Wc		
log Urbanization	-0.130	-0.151
	(0.129)	(0.130)
Observations	198	198
Wald Test of Spatial Terms	1.012	1.349

Table reports the estimates of the effect of maize on population density and urbanization. Panel A reports the results from the regression of the natural log of population density (people/km^2) regressed on the natural log of maize suitability interacted with an indicator for post maize introduction and other controls. Panel B reports the results from the regression of the natural log of urbanization (urban population/total population) regressed on the natural log of maize suitability interacted with an indicator for post maize introduction and other controls. Wc log population density and log urbanization are spatial lag terms weighted by contiguity. the All columns include controls for European contact and climate. The post maize introduction variable and the post potato introduction variable takes the value of 1 for any period after 1615. All regressions include state and period fixed effects. Standard are clustered at the state level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$

Table 3.7: Estimated Impacts on Population Density and Urbanization

	(1)			(2)		
Panel A: Population Density						
	Direct Impact	Indirect Impact	Total Impact	Direct Impact	Indirect Impact	Total Impact
ln(Maize)×Post	0.0266***	-0.0018*	0.0248***	0.0262**	-0.0017*	0.0244***
	(0.0099)	(0.0010)	(0.0090)	(0.0112)	(0.0010)	(0.0103)
Mughal				0.0422***	-0.0025*	0.0397***
				(0.0171)	(0.0014)	(0.0160)
ln(Rice)				-0.0137	0.0010	-0.0127
				(0.0090)	(0.0006)	(0.0084)
Panel B: Urbanization						
ln(Maize)×Post	0.0043***	-0.0004	0.0039***	0.0040**	-0.0004	0.0036**
	(0.0015)	(0.0004)	(0.0013)	(0.0018)	(0.0004)	(0.0016)
Mughal				-0.0023	0.0002	-0.0021
				(0.0028)	(0.0003)	(0.0025)
ln(Rice)				0.0013	-0.0001	0.0011
				(0.0015)	(0.0002)	(0.0013)

These results indicate that a 1 percent increase in the suitability conditions for growing maize has a direct impact on a state's population density, increasing it by 0.0266 percent. The spillover effect of increasing maize by 1 percent is to reduce population density by 0.0018 percent. Together, the total impact on population density is a 0.0248 percent increase. When taking the effects of Mughal expansion and its impact on rice cultivation, the results for the impact of the introduction of maize remain stable. A one percent increase in the growing conditions for maize increase population density by 0.0244 percent (0.0262 direct effect and -0.0017 indirect effect). The negative indirect effects suggest that populous state attracts more population growth from its neighboring states, concentrating density into a select number of states.

The expansion of the Mughal Empire also impacts the population density within a state. The average total impact of the Empire expanding into a state increases population density by 3.97 percent. There are also negative spillovers associated with the expansion of the Mughal Empire. The indirect effect of expansion decreases population density by 0.25 percent.

The results in Panel A suggest that when accounting for population spillovers, the introduction of maize does have a net positive effect on population density. The estimated effect is small, and it is unclear whether this result is economically significant. To better understand how maize impacts populations density, I determine the introduction of maize's contribution to the overall growth in population density. The introduction of maize increased the population density of the average state between 7.8% and 7.7% (total impact of the introduction of maize multiplied by the average maize suitability of 3.15). According to the data, the average state had a population density of 42.5 people per square kilometer in 1600 and 82 people per square kilometer in 1800. This suggests that population density grew by about 93%. Thus maize contributed to about 8.2% of the increase in population density during this period, which is a similar effect as the expansion of the Mughal empire.

Panel B of Table 3.7 shows that when controlling for spatial spillovers, there is also a positive and significant effect of the introduction of maize on urbanization. Increasing the suitability for growing maize by 1 percent increases the urbanization in a state between 0.0036 percent and 0.0043 percent. The individual indirect effects are not statistically significant, so the range of potential impacts spans the range for both the total and direct impacts. These results are consistent with other specifications for urbanization. Based on these estimates, the introduction of maize contributes between 7% and 8% of the growth in urbanization from 1600 to 1800, which is the same contribution as the baseline estimates.

The effect of the expansion of the Mughal Empire on urbanization is of similar magnitude as in Table 3.5, however this effect is no longer statistically significant when controlling for spatial dependencies between states. There is also no effect of increased rice cultivation because of the Mughal empire. In contrast to the spatial spillovers from population density, the average spatial spillovers are not statistically different from 0. However, I fail to reject the null hypothesis that all spatial terms are equal to 0 for both specifications ($\chi^2_1 = 1.012$ and $\chi^2_1 = 1.349$). This suggest that there are some spatial dependencies between states that should be accounted for despite their average effect being statistically insignificant.

The results from Panel A combined with the results in Panel B suggest that the introduction of maize did impact economic growth in India before 1800. Its introduction increased both population density as well as urbanization, two indicators, which when taken together, suggest that economic growth did occur. Maize was a significant enough agricultural productivity shock that India was able to escape its Malthusian paradigm.

3.6 Conclusion

This paper analyzed the impacts of the introduction of a New World crop in the economy of Pre-colonial India. For the introduction of a New World crop to impact the economy is must provide a sufficient technological shock by being richer in necessary nutrients and more productive

than existing crops. This paper finds evidence that maize fulfills these criteria. Using variation in the ability of states to successfully grow maize, I find that the introduction of maize did significantly increase modern economic growth during this time period when accounting for spatial spillovers. Increasing the suitability for growing maize by 1% increases population density by 0.0244% and urbanization by 0.0036%, which means that for the sample period, the introduction of maize contributed 9% of the total population growth and 8% of the total growth in urbanization.

Alternative explanations for the growth in population density and urbanization were also tested. One explanation was the possibility that other crops caused were the determinant of this growth instead of maize. When these alternative crops were included, the impact from the introduction maize was no longer statistically significant, but other measure indicate that these alternative specifications do not perform as well as the simple difference-in-differences, baseline results. Another explanation, was the effect of the expansion of the Mughal Empire impacted economic growth. I do find some evidence for this hypothesis, but even when controlling for these factors maize continues to be a determinant of the growth in urbanization and population density.

The spatial aspect of economic growth is also an important consideration. The growth from one state can impact another, which then recursively impacts the first. I do find that this dynamic occurs for the introduction of maize, and the net result of the direct and indirect impacts increases economic growth. This suggests that the introduction of maize is a sufficient agricultural productivity shock to spur economic growth, and that the introduction of maize did allow for India to escape its Malthusian trap during this period of history.

Chapter 3 References

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Appendix

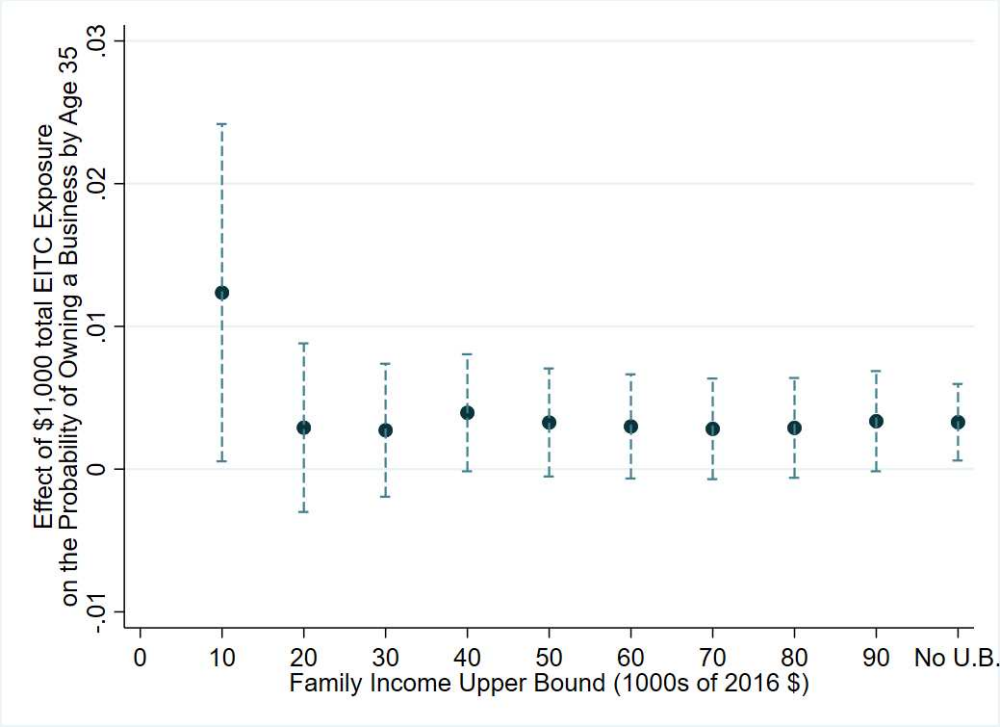

Figure A.1: The Effect Earned Income Tax Credit (EITC) Exposure on Business Ownership by Income Threshold

Table A.1: The Effect of the Earned Income Tax Credit (EITC) on Risk Preferences: Ordered Probit and Ordered Logit

	(1)	(2)	(3)	(4)
	O. Probit	O. Probit	O. Logit	O. Logit
Risk Score				
Total EITC Exposure ($000s)	-0.00871*		-0.0197**	
	(0.00502)		(0.00884)	
EITC Exposure Age 0-5 ($000s)		-0.136		-0.211
		(0.103)		(0.192)
EITC Exposure Age 6-12 ($000s)		0.0181		0.0238
		(0.0271)		(0.0472)
EITC Exposure Age 13-18 ($000s)		-0.0149		-0.0306*
		(0.00959)		(0.0170)
Observations	1903	1903	1903	1903
Pseudo R^2	0.075	0.076	0.078	0.078

Table A.2: National Longitudinal Survey of Youth 1979: Child and Young Adult Risk Assessment

	Strongly Disagree 1	2	3	Strongly Agree 4
I often get in a jam because I do things without thinking				
I think that planning takes the fun out of things				
I have to use a lot of self-control to keep out of trouble				
I enjoy taking risks				
I enjoy new and exciting experiences, even if they are a little frightening or unusual				
Life with no danger would be dull for me				